

# For 2Cell Solar, Synchronous Switch-Mode Charger IC

## BU1840AMUV

### ●General Description

The BU1840AMUV device provides the best system to the product charged with 1cell Li-ion battery and 3cell Nickel-metal-hydrde batteries using the 2cell, 3cell, and 4cell solar panel.

It is possible to boost it according to the voltage of 2 cell solar panel with built-in the function to boost the low voltage input.

Moreover, the solar battery maximum dissipation can be drawn out with built-in the peak power track function. It is possible to select the the switching frequency according to the terminal SEL.

It is also possible to monitor the charging current by the I2C interface.

Built in heat reckless driving protection (Thermal shutdown), decrease voltage protection, and input current protection for protection function

### ●Features

- Synchronous Switch-Mode Charger for 2Cell Solar  
400mA@Battery=3.7V,VIN=1V
- MPPT control voltage range : 0.7V~1.5V
- Charging current completion voltage :  
5.0V (hysteresis: 0.075V)
- Built in MPPT
- Switching frequency (160kHz,320kHz)
- Charging current monitor by I2C
- UVLO-detect Voltage:0.625V
- UVLO-release Voltage:0.700V
- Thermal Shutdown
- 24 pin VQFN024V4040 (4.1mm × 4.1mm<MAX>)

### ●Applications

- Solar mobile phone
- Solar audio
- Solar portable charger
- Solar LED illumination

### ●Package(s)

VQFN024V4040

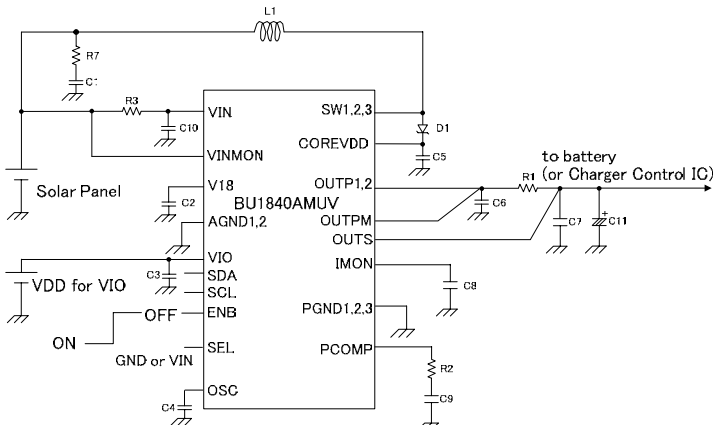
W(Typ.) x D(Typ.) x H(Max.)

4.00mm x 4.00mm x 1.00mm



### ●Typical Application Circuit(s)

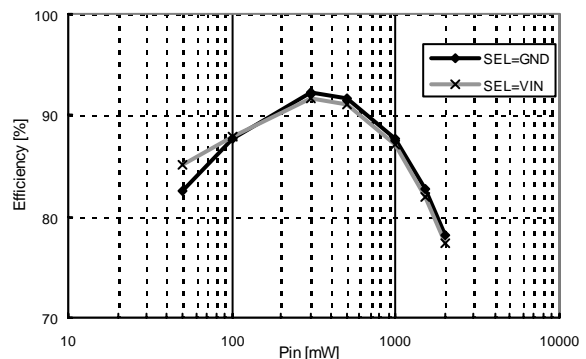
<For 2 Cells Solar>



### ●Typical Performance characteristics

<Efficiency (for 2 cells solar)>

(VINMON=1.0V, OUTS=3.7V, Pin = 50mW ~ 2W)



## ● Absolute maximum ratings (Ta=25°C)

Parameter	Symbol	Ratings	Unit	Conditions
Maximum applied voltage 1	Vmax1	7.0	V	VIO,SDA,SCL,SW1,2,3, ENB COREVDD,OUTP1,2,OUTPM,OUTS
Maximum applied voltage 2	Vmax2	2.5	V	VIN,VINMON,V18,IMON,PCOMP, SEL,OSC
Power dissipation1	Pd1	560	mW	1layer(74.2x74.2mm)board (Surface heat radiation copper foil: 6.28mm <sup>2</sup> )
Power dissipation2	Pd2	1766	mW	4layer(74.2x74.2mm)board (1,4layer heat radiation copper foil: 6.28mm <sup>2</sup> ) (2,3layer heat radiation copper foil: 5500mm <sup>2</sup> )
Operating temperature range	Topr	-30~+85	°C	
Storage temperature range	Tstr	-55~+150	°C	

\*1 When it is used by more than Ta=25°C, it is reduced by 5.6mW/°C. \*1

\*2 When it is used by more than Ta=25°C, it is reduced by 17.66mW/°C.

## ● Operating conditions (Ta=25°C)

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage range 1	VCC1	0.625~1.98	V	VIN terminal voltage
Power supply voltage range 2	VCC2	1.7~5.5	V	VIO terminal

## ● Electrical characteristics (Unless otherwise specified: Ta=25°C, VIN=1.0V)

Parameter	Symbol	Rating			Unit	Conditions
		Min.	Typ.	Max.		
MPPT control minimum voltage	MPPTL	-	-	0.7	V	VINMON-monitor
MPPT control maximum voltage	MPPTH	1.5	-	-	V	VINMON-monitor
MPPT-VIN control voltage resolution	PPTVT	12.5	25.0	37.5	mV	
UVLO Release Threshold	VuvloR	0.6	0.7	0.8	V	VIN-rising
UVLO Detect Threshold	VuvloD	0.575	0.625	0.675	V	VIN-falling
UVLO Hysteresis	Vuvlohys	30	80	130	mV	
MPPT start up voltage	Vst1	2.45	2.6	2.75	V	COREVDD-monitor (hys=0.3V)
Charging current completion voltage	Vch2	4.93	5.0	5.07	V	OUTS-monitor RISING. (hysteresis=0.075V)
Circuit current 1 (VIN-CURRENT)	ICC1	-	-	1.0	mA	ENB=1V, SW=VIN
Circuit current 2 (OUTS-CURRENT)	ICC2	-	-	2	uA	ENB=1V, OUTS,P=5.2V, COREVDD=3.7V
Circuit current 3 (OUTS-CURRENT) Not-Switching	ICC3	-	-	4	uA	ENB=0V, OUTS,P=5.2V COREVDD=3.7V
Nch-SW ON register	Rnsw	-	60	-	mΩ	
Pch-SW ON register	Rpsw	-	100	-	mΩ	
Input over current limiter	Vlim	3.0	4.0	5.0	A	
DCDC switching frequency 1 (SEL=VIN)	Fosc1	260	320	380	kHz	OSC2OUT
DCDC switching frequency 2 (SEL=GND)	Fosc2	130	160	190	kHz	OSC2OUT
Charging current voltage range	Vlmon	0		40	mV	V(OUTPM)-V(OUTS)
Charging current monitor accuracy 1	lmon1	0D	2B	49	Hex	V(OUTPM)-V(OUTS)=0mV
Charging current monitor accuracy 2	lmon2	88	A6	BF	Hex	V(OUTPM)-V(OUTS)=40mV
Logic operating clock	Logosc	-	30	-	kHz	C4=100pF
ENB "H" level voltage	Venh	1.1	-	-	V	POWER-OFF
ENB "L" level voltage	Venl	0	-	0.2	V	POWER-ON

●Electrical characteristics (Unless otherwise specified: Ta=25°C, VIO=1.8V)

Item	Symbol	Min.	Typ.	Max.	Unit	Conditions
<b>【I<sup>2</sup>C input (SDA, SCL)】</b>						
L level input voltage	VIL1	-0.3	-	0.25 × VIO	V	
H level input voltage	VIH1	0.75 × VIO	-	VIO +0.3	V	
Hysteresis width	Vhys1	0.05 × VIO	-	-	V	
L level output voltage (Sink current = 3mA)	VOL1	0	-	0.3	V	SDA pin
Input current	Iin1	-3	-	3	μ A	Pin voltage=0~VIO

●I<sup>2</sup>C BUS format

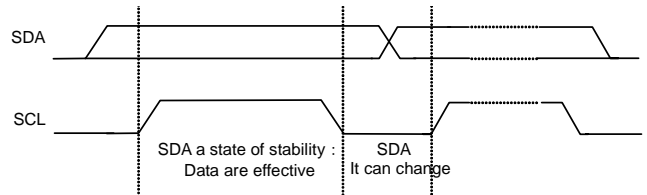
The writing/reading operation is based on the I<sup>2</sup>C slave standard.

- Slave address

A7	A6	A5	A4	A3	A2	A1	R/W
1	1	1	0	0	0	1	1/0

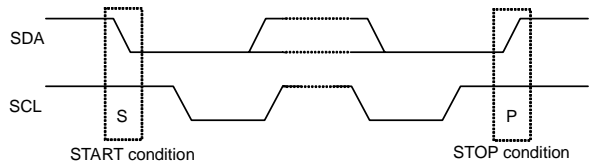
- Bit Transfer

SCL transfers 1-bit data during H. SCL cannot change signal of SDA during H at the time of bit transfer. If SDA changes while SCL is H, START conditions or STOP conditions will occur and it will be interpreted as a control signal.



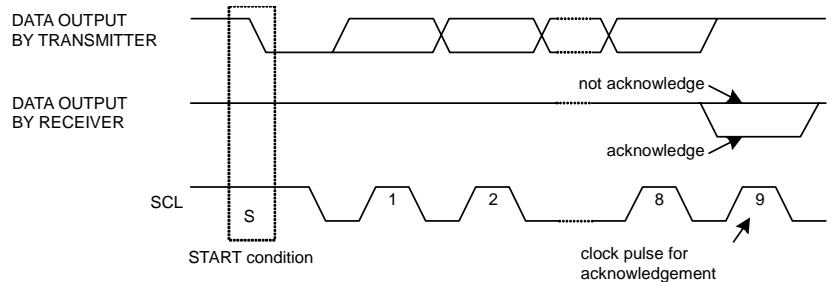
- START and STOP condition

When SDA and SCL are H, data is not transferred on the I<sup>2</sup>C- bus. This condition indicates, if SDA changes from H to L while SCL has been H, it will become START (S) conditions, and an access start, if SDA changes from L to H while SCL has been H, it will become STOP (P) conditions and an access end.



- Acknowledge

It transfers data 8 bits each after the occurrence of START condition. A transmitter opens SDA after transfer 8bits data, and a receiver returns the acknowledge signal by setting SDA to L.

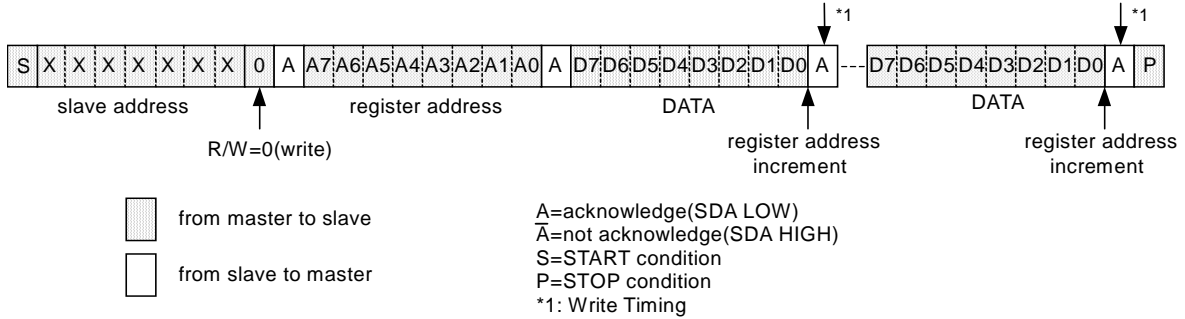


- Protocol

Legend			
	The mastering side is a transmitter. The slave side is a receiver.		Acknowledge
	The slave side is a transmitter. The mastering side is a receiver.		Unacknowledged
	Start condition		Stop condition
	Repetition start condition		

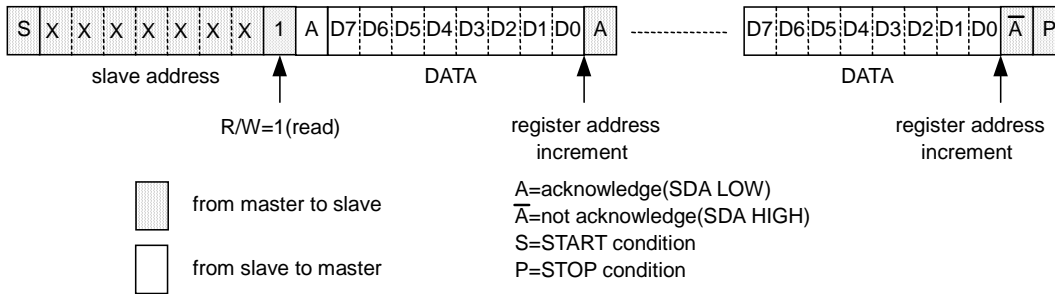
1. Writing protocol

A register address is transferred by the next 1 byte that transferred the slave address and the write-in command. The 3rd byte writes data in the internal register written in by the 2nd byte, and after 4th byte or, the increment of register address is carried out automatically. However, when a register address turns into the last address, it is set to 00h by the next transmission. After the transmission end, the increment of the address is carried out.



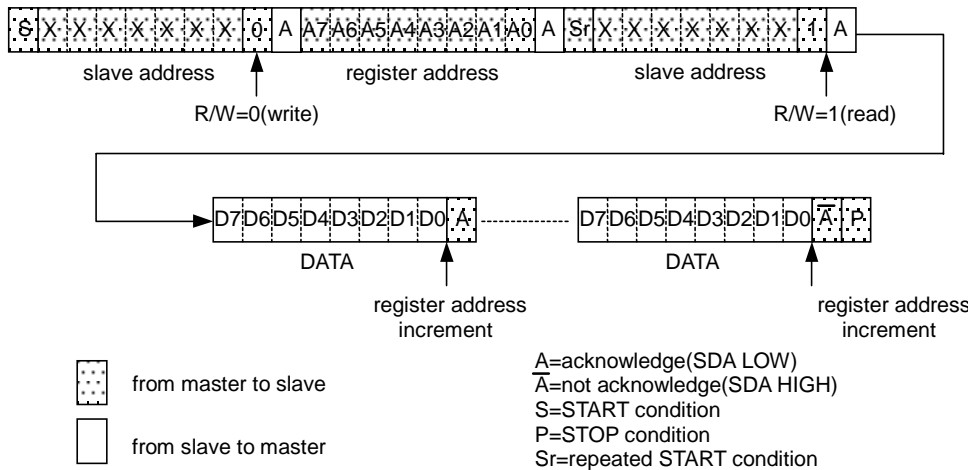
2. Reading protocol

It reads from the next byte after writing a slave address and R/W bit. The register to read considers as the following address accessed at the end, and the data of the address that carried out the increment is read after it. If an address turns into the last address, the next byte will read out 00h. After the transmission end, the increment of the address is carried out.



3. Multiple reading protocols

After specifying an internal address, it reads by repeated START condition and changing the data transfer direction. The data of the address that carried out the increment is read after it. If an address turns into the last address, the next byte will read out 00h. After the transmission end, the increment of the address is carried out.

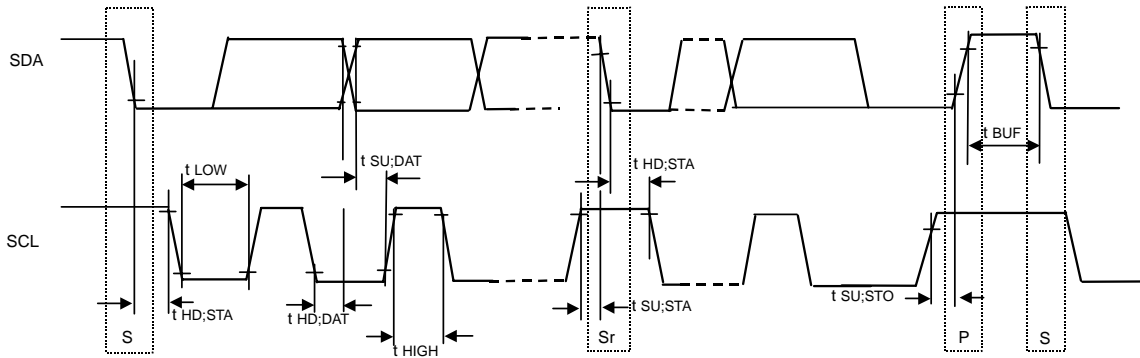


※ As for reading protocol and multiple reading protocols, please do A-bar (not acknowledge) after doing the final reading operation. It stops with read when ending by A (acknowledge), and SDA stops in the state of Low when the reading data of that time is 0. However, this state returns usually when SCL is moved, data is read, and A-bar (not acknowledge) is done.

●Electrical Characteristics(Unless otherwise specified, Ta=25 °C, VIO=1.8V)

Item	Symbol	Standard-mode			Fast-mode			Typ.
		Min.	Typ.	Max.	Min.	Typ.	Max.	
<b>【I<sup>2</sup>C BUS format】</b>								
SCL clock frequency	fSCL	0	-	100	0	-	400	kHz
LOW period of the SCL clock	tLOW	4.7	-	-	1.3	-	-	μs
HIGH period of the SCL clock	tHIGH	4.0	-	-	0.6	-	-	μs
Hold time for a repeated START condition	tHD;STA	4.0	-	-	0.6	-	-	μs
Set-up time for a repeated START condition	tSU;STA	4.7	-	-	0.6	-	-	μs
Data hold time	tHD;DAT	0	-	3.45	0	-	0.9	μs
Data set-up time	tSU;DAT	250	-	-	100	-	-	ns
Set-up time for STOP condition	tSU;STO	4.0	-	-	0.6	-	-	μs
Bus free time between a STOP and START condition	tBUF	4.7	-	-	1.3	-	-	μs

●Timing diagram



●Register Map

Address	Symbol Name	R/W	D7	D6	D5	D4	D3	D2	D1	D0	INITIAL	Function
00h	SFTRST	W	-	-	-	-	-	-	-	SFT RST	00h	
01h	ADCDATA	R	ADC DATA7	ADC DATA6	ADC DATA5	ADC DATA4	ADC DATA3	ADC DATA2	ADC DATA1	ADC DATA0	00h	

Please input "0" to "-".

In an empty address, there is a possibility of doing assign to the register for the test.

The access to a register for the test and an undefined register is prohibited.

The I<sup>2</sup>C control timing and the internal operation of IC timing become asynchronous relations when reading out data from the outside.

I hope measures so as not to become a problem on the application as the agreement sequence is compare three times.

## ●Register Explanation

Address	Symbol Name	R/W	D7	D6	D5	D4	D3	D2	D1	D0	INITIAL	データ内容
00h	SFTRST	W	-	-	-	-	-	-	-	SFT RST	00h	ソフトウェア リセット制御入力

Bit name	Bit	Function	0	1
SFTRST	D0	RST (All registers are initialized.)	Normal	Reset

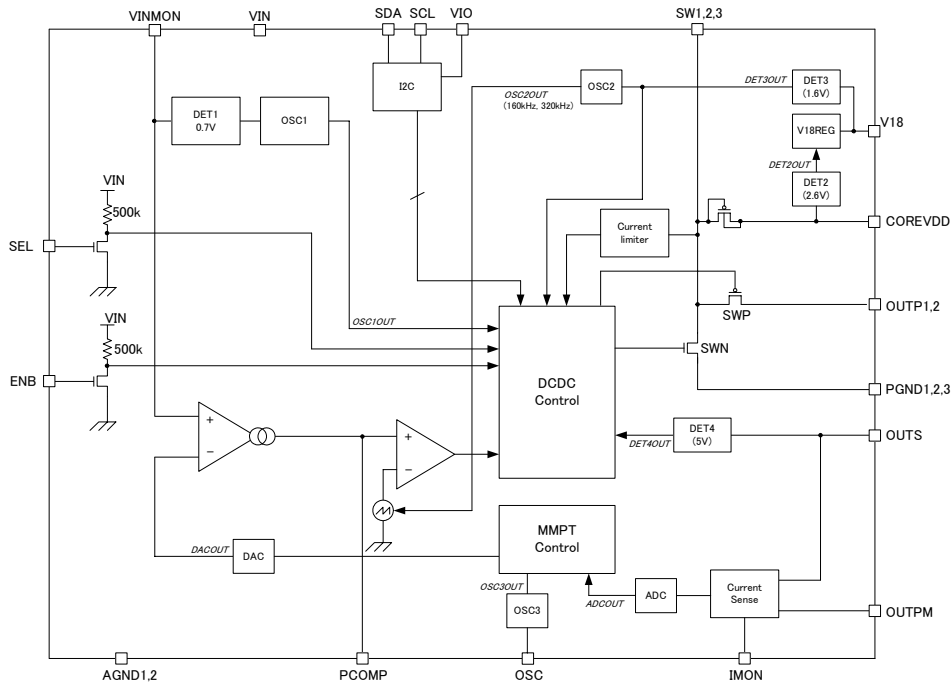
After initializing this all registers when SFTRST: D0=1 is done in WRITE, the value of this register returns to an initial value, too.

Address	Symbol Name	R/W	D7	D6	D5	D4	D3	D2	D1	D0	INITIAL	データ内容
01h	ADCDATA	R	ADC DATA7	ADC DATA6	ADC DATA5	ADC DATA4	ADC DATA3	ADC DATA2	ADC DATA 1	ADC DATA0	00h	

D7-D0: ADCDATA7-0  
8bitADC data (Initial 00h)

Note) When not charging it (V18<1.6V & DET4OUT=HI <full charge>), doesn't return the acknowledge signal.

●Block diagram



●Block Operation Characteristics

DET1 : The voltage of VINMON is detected. (It has hysteresis characteristics.)

0.700V-DETECT  
0.625V-RELEASE

DET2 : The voltage of COREVDD (2.6V) is detected. (It has hysteresis characteristics.)

2.6V-DETECT  
2.3V-RELEASE

DET3 : The voltage of V18 is detected. (It has hysteresis characteristics.)

1.6V-DETECT  
1.5V-RELEASE

DET4 : The voltage of OUTS is detected. (It has hysteresis characteristics.)

5.0V-DETECT  
4.925V-RELEASE

OSC1 : It is an oscillator. It operates at the self-excitation boost.

OSC2 : It is an oscillator. It operates at MPPT.

SEL= GND : frequency=160kHz  
SEL= VIN : frequency=320kHz

OSC3 : It is an oscillator. It uses it for the clock in the MPPT-CONTROL Block and the A/D Block.

DAC : It is D/A converter. A standard voltage of MPPT is output.

ADC : It is A/D converter. The analogue signal amplified in the Current-Sense block is converted into the digital signal.

Current-Sense : The OUTPM-OUTS voltage is amplified.

V18REG : Internal power supply V18 is generated from COREVDD.

Current-limiter : The current that flows from SW to PGND is detected.

I2C : It is I2C interface block. VIO is made a power supply.

MPPT-Control : To charge it by the solar battery maximum dissipation, it controls.

### ●Charging Current Sense Register (R1)

It is necessary to decide the constant of R1 in proportion to the maximum charge current.

Maximum charging current = "Maximum input power" × "Efficiency" ÷ "Voltage of battery"

Maximum charging current [mA]	R1 [mΩ]	Maximum charging current [mA]	R1 [mΩ]
60	560	350	100
80	470	400	100
100	390	480	82
120	330	580	68
150	220	700	56
200	180	820	47
250	150	1000	39
300	120	1200	33

### ●Charging Current Data

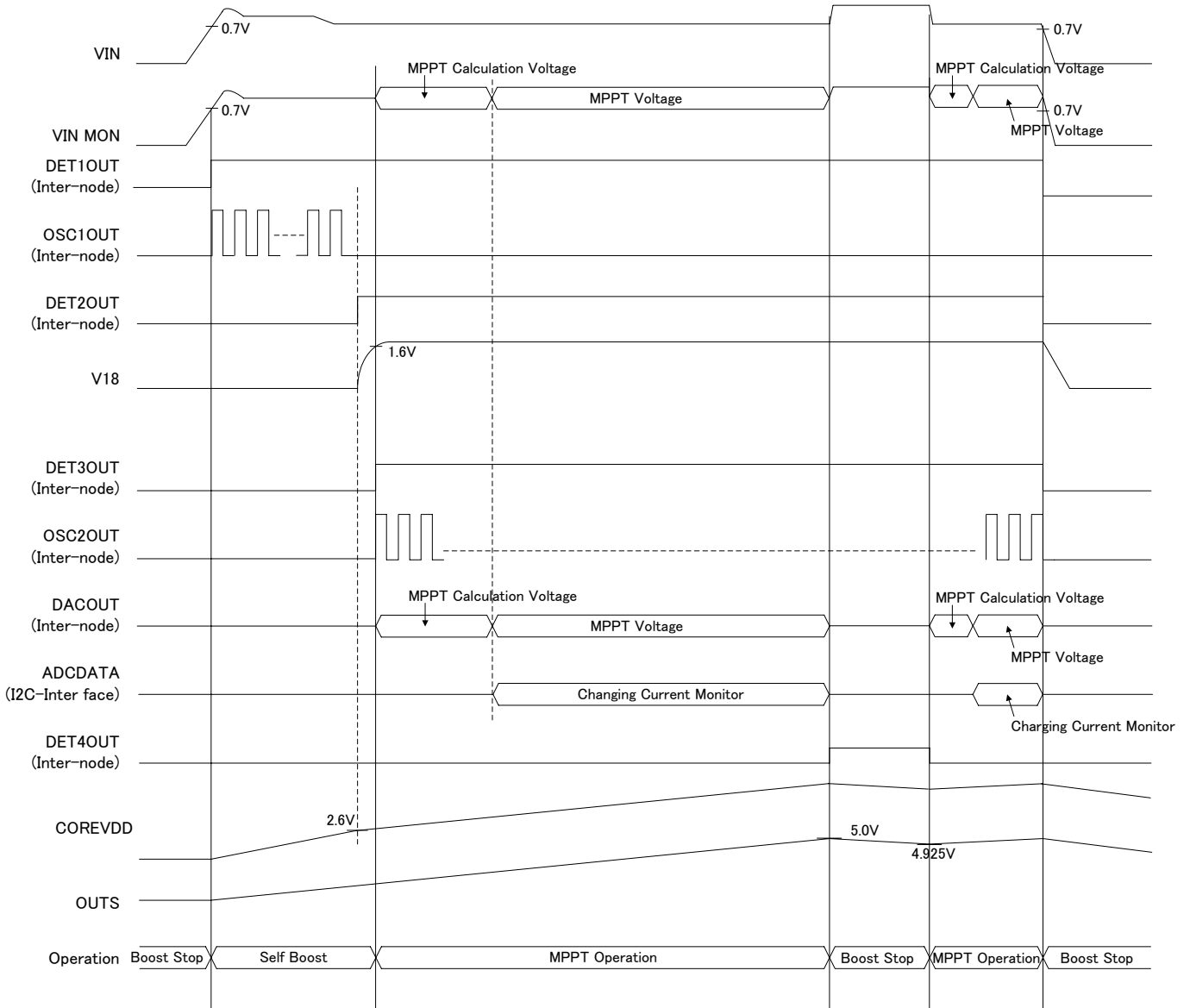
The current for each 1bit of the charge current data is decided by the following calculating formula

Charging current=(Charging current data[Hex]–2B[Hex]) × "Charging current / 1bit"

R1 [mΩ]	Charging current/1bit [mA]	R1 [mΩ]	Charging current/1bit [mA]
33	9.685	150	2.131
39	8.195	180	1.776
47	6.800	220	1.453
56	5.707	270	1.184
68	4.700	330	0.9685
82	3.898	390	0.8195
100	3.196	470	0.6800
120	2.663	560	0.5707



●Operating Sequence



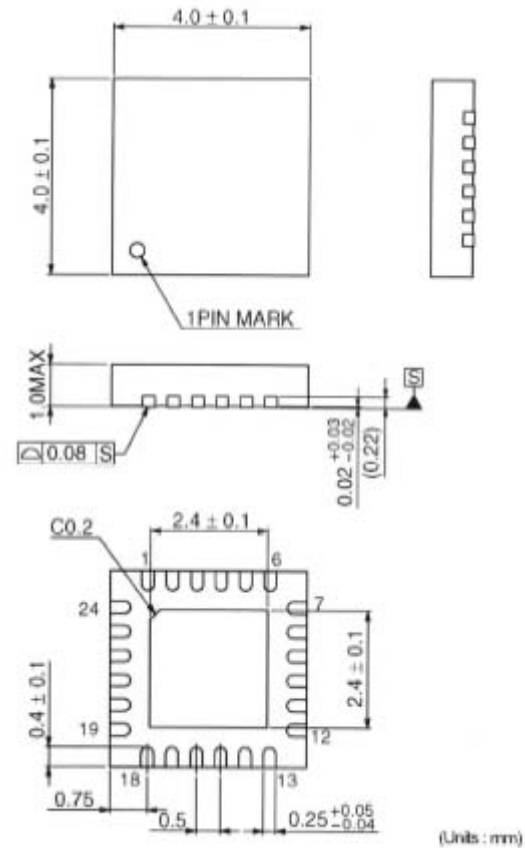
Note) When MPPT operating, it is calculated of MPP each 158mS. (Logosc=30kHz)  
 The amount of the MPP voltage change is 25mV step.

●Pin Layout

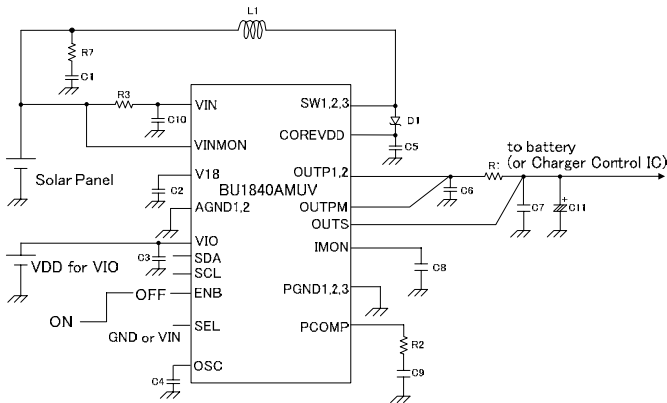
No.	PIN Name	Function	ESD Diode	
			High side	GND side
1	SCL	I2C Interface clock input pin	VIO	AGND
2	SDA	I2C Interface data input and output pin	VIO	AGND
3	VINMON	VIN monitor pin	-	AGND
4	IMON	-	COREVDD	AGND
5	OUTS	Charging current sense pin 1	-	AGND
6	AGND1	GND pin	COREVDD	AGND
7	OUTP1	Output voltage pin	-	AGND
8	OUTP2	Output voltage pin	-	AGND
9	SW1	Inductor connect pin	-	-
10	SW2	Inductor connect pin	-	-
11	SW3	Inductor connect pin	-	-
12	OUTPM	Charging current sense pin 2	-	AGND
13	PGND1	GND pin	COREVDD	AGND
14	PGND2	GND pin	COREVDD	AGND
15	PGND3	GND pin	COREVDD	AGND
16	COREVDD	Internal power supply 1	COREVDD	AGND
17	V18	Internal power supply 2	V18	AGND
18	SEL	DCDC switching frequency changing pin SEL = GND : 160kHz SEL = VIN : 320kHz	VIN	AGND
19	VIN	Solar battery input pin	VIN	AGND
20	OSC	Logic frequency adjustment pin	V18	AGND
21	PCOMP	Phase compensation pin	V18	AGND
22	AGND2	GND pin	V18	AGND
23	ENB	Chip enable pin (ON:L, OFF:H)	-	AGND
24	VIO	Power supply pin for interface  (When I2C Interface is not used, please connect VIO pin to COREVDD pin.)	VIO	AGND

●Package Diagram

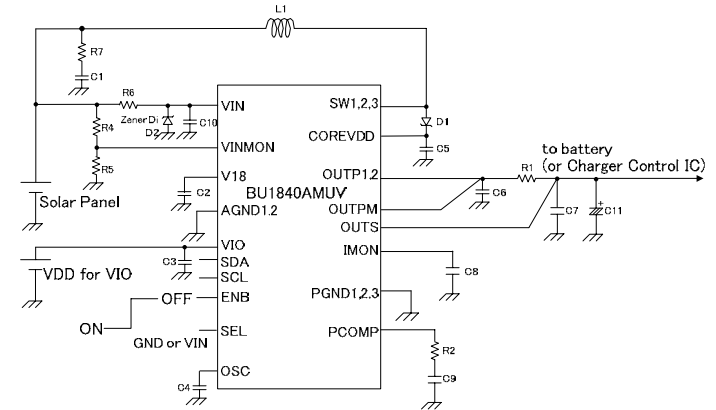
VQFN024V4040VQ



●How to select parts of application  
<For 2 Cells Solar>



<For 4 Cells Solar>



	Value	Maker	Parts
R1	※1	-	-
R2	24kΩ	-	-
R3	10Ω	-	-
R7	100mΩ	-	-
C1	200uF	-	-
C2	0.47uF	-	-
C3	0.1uF	-	-
C4	100pF	-	-
C5	22uF	-	-
C6	2.2uF	-	-
C7	100uF ※2	-	-
C8	22nF	-	-
C9	47nF	-	-
C10	10uF	-	-
C11	470uF ※2	-	-
L1	4.7uH~10uH	TOKO	D128C
D1*	SBD	-	-

	Value	Maker	Parts
R1	※1	-	-
R2	24kΩ	-	-
R3	10Ω	-	-
R4	100kΩ	-	-
R5	100kΩ	-	-
R6	1kΩ	-	-
R7	100mΩ	-	-
C1	200uF	-	-
C2	0.47uF	-	-
C3	0.1uF	-	-
C4	100pF	-	-
C5	22uF	-	-
C6	2.2uF	-	-
C7	100uF ※2	-	-
C8	22nF	-	-
C9	47nF	-	-
C10	10uF	-	-
C11	470uF ※2	-	-
L1	4.7uH~10uH	TOKO	D128C
D1*	SBD	-	-
D2	Zener Di	RENESAS	HZ2A1

※1 Please set a optimal value for R1 depending on maximum charging current. For details, please see p.8 "Charge Current Sense Register (R1)".

※2 Recommended capacitance value of output (OUTS pin) is equivalent to at least 570uF, it is the total of C7(ceramic capacitors) and C11(aluminum electrolytic capacitors) or C7(ceramic capacitors) and C11(tantalum capacitors).

When select the ceramic capacitor, it takes some consideration of DC bias effect(s). (Recommended pressure capacity:over 10V) With sensitive application to output ripple voltage, taking measures to reduce ESR(Equivalent Series Resistance) such as increasing of ceramic capacitor or parallel capacitor.

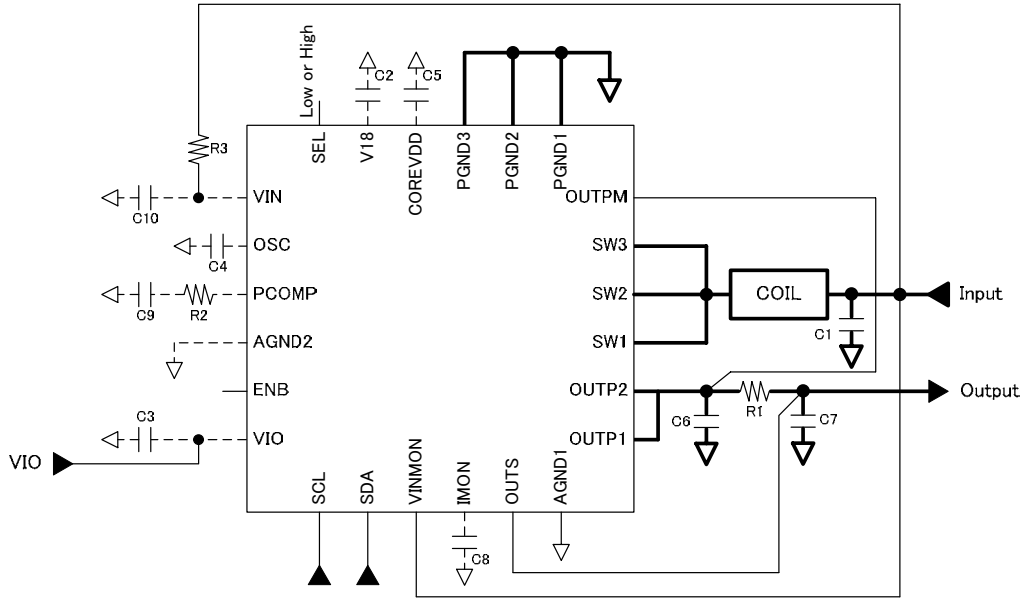
\* On BU1840AMUV, output voltage (OUTS pin voltage) rise up to 5.07V; it is the highest value of the charge current completion voltage. Please insert the charging control IC between BU1840AMUV output and secondary battery as necessary.

\* When I2C interface is not in use, please connect VIO pin with COREVDD pin directly.

\* In case of charging of the battery with low voltage (less than 3.0V), There is a probability of the emergence of the pattern periodically repeating MPPT active/non-active mode and it will cause noise. Please insert SBD between SW pin and COREVDD pin to reduce such noise as necessary.

●Notes of board layout

BU1840AMUV is switching DCDC converter, so characteristics of noise and etc changing by board layout. Please note the following respect besides a general board layout matter when you make PCB.



— Line Please shorten power supply-coil GND loop.  
 - - - - Line Please shorten.

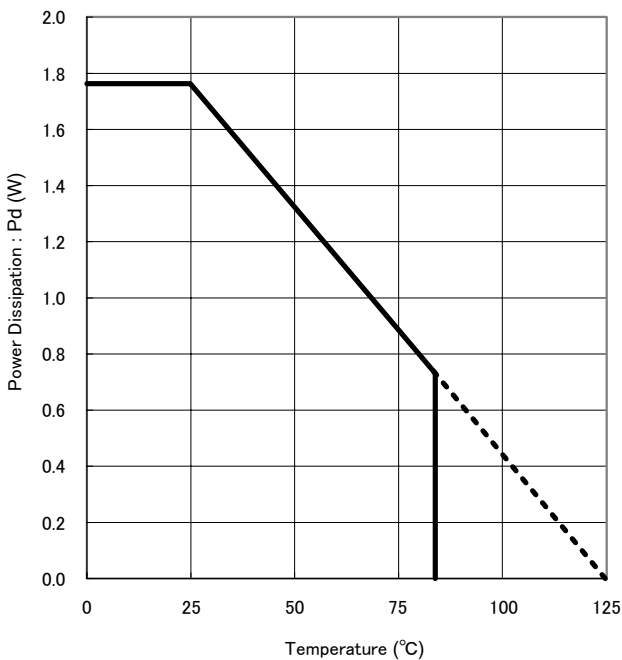
●About heat loss

In the heat design, please operate it in the following condition.

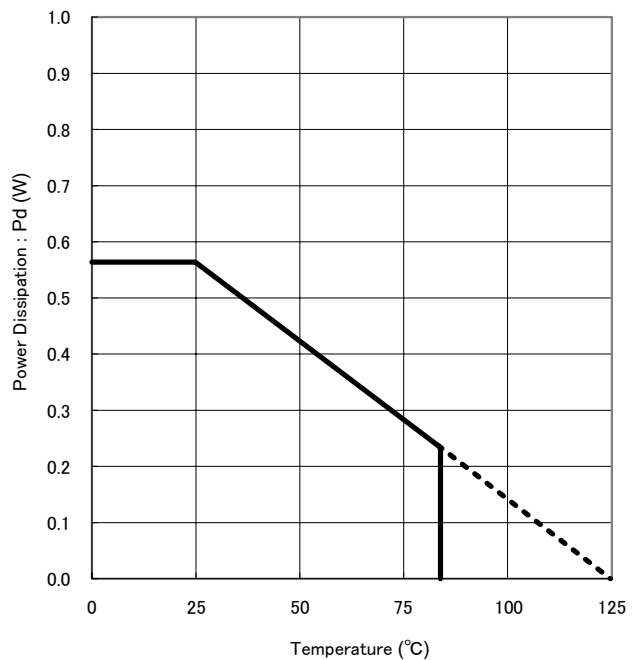
(Please consider the margin etc. because the following temperature is a guarantee temperature.)

1. Surrounding temperature  $T_a$  must be 85°C or less.
2. Loss of IC must be permissible loss  $P_d$  or less.

The allowable dissipation ( $P_d$ ) characteristics are described below.



4layer(74.2 × 74.2mm)board  
 (1,4layer heat radiation copper foil : 6.28mm<sup>2</sup>)  
 (2,3layer heat radiation copper foil : 5500mm<sup>2</sup>)



1layer(74.2 × 74.2mm)board  
 (Surface heat radiation copper foil : 6.28mm<sup>2</sup>)

**●Caution on 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 devices, thus making impossible to identify breaking mode such as a short circuit or an open circuit. If any special mode exceeding the absolute maximum ratings is assumed, consideration should be given to take physical safety measures including the use of fuses, etc.

**(2) The power supply and the GND lines**

Design PCB pattern to provide low impedance for the wiring between the power supply and the GND lines. Please take care about interference by common impedance of the wiring pattern when there are two or more power supply and GND line. For the GND line, please note the separation of the large current route and the small signal route including the external circuit. Furthermore, for all power supply terminals to ICs, mount a capacitor between the power supply and the GND terminal. At the same time, in order to use an electrolytic capacitor, thoroughly check to be sure the characteristics of the capacitor to be used present no problem including the occurrence of capacity dropout at a low temperature, thus determining the constant.

**(3) GND voltage**

Make setting of the potential of the GND terminal so that it will be maintained at the minimum in any operating state.

**(4) Short circuit between terminals and erroneous mounting**

In order to mount ICs on a set PCB, pay thorough attention to the direction and offset of the ICs. Erroneous mounting can break down the ICs. Furthermore, if a short circuit occurs due to foreign matters entering between terminals or between the terminal and the power supply or the GND terminal, the ICs can break down.

**(5) Operation in strong electromagnetic field**

Be noted that using ICs in the strong electromagnetic field can malfunction them.

**(6) Input terminals**

In terms of the construction of IC, parasitic elements are inevitably formed in relation to potential. The operation of the parasitic element can cause interference with circuit operation, thus resulting in a malfunction and then breakdown of the input terminal. Therefore, pay thorough attention not to handle the input terminals, such as to apply to the input terminals a voltage lower than the GND respectively, so that any parasitic element will operate. Furthermore, do not apply a voltage to the input terminals when no power supply voltage is applied to the IC. In addition, even if the power supply voltage is applied, apply to the input terminals a voltage lower than the power supply voltage or within the guaranteed value of electrical characteristics.

**(7) External capacitor**

In order to use a ceramic capacitor as the external capacitor, determine the constant with consideration given to a degradation in the nominal capacitance due to DC bias and changes in the capacitance due to temperature, etc.

**(8) Thermal design**

Perform thermal design in which there are adequate margins by taking into account the permissible dissipation (Pd) in actual states of use. Moreover, please use it within the range where output Tr doesn't exceed the rated voltage and ASO.

**(9) Rush current**

In CMOS IC, when the power supply is turned on rush current might flow momentarily in logical internal irregular state. Therefore, note drawing the capacity of the power supply coupling, the power supply, and width and drawing the GND pattern wiring, please.

**(10) Test terminal and unused terminal processing**

Please process a test terminal and unused terminal according to explanations of the function manual and the application note, etc. to be unquestionable while real used. Moreover, please inquire of the person in charge of our company about the terminal without the explanation especially.

**(11) Content of material**

The application notes etc. are the design material to design the application, and no one of the content securing it. Please decide the application after it examines enough and it evaluates it including external parts.

**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 part number

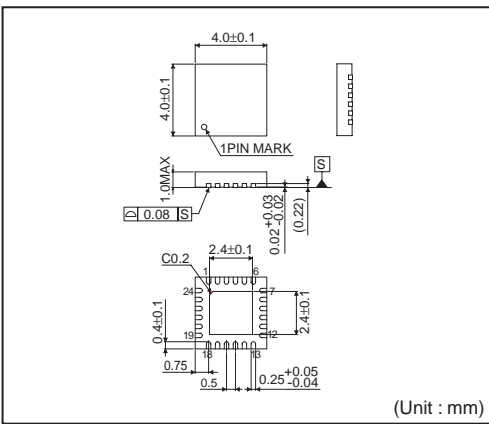
B U 1 8 4 0 A M U V

-
E 2

<p><b>Part No.</b></p>	<p><b>Package</b></p> <p>MUV : VQFN024V4040</p>	<p><b>Wrapping, Forming specification</b></p> <p>E2: Reel emboss taping</p>
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●Physical Dimension Tape and Reel Information

**VQFN024V4040**



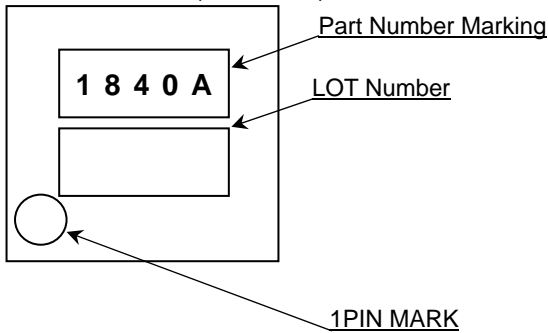
<Tape and Reel information>

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

\*Order quantity needs to be multiple of the minimum quantity.

●Marking Diagram(s)

VQFN024V4040 (TOP VIEW)



# Notice

## Precaution on using ROHM Products

- 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 <sup>(Note 1)</sup>, 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
CLASS III	CLASS III	CLASS II b	CLASS III
CLASS IV		CLASS III	

- 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:
  - Installation of protection circuits or other protective devices to improve system safety
  - Installation of redundant circuits to reduce the impact of single or multiple circuit failure
- 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:
  - Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
  - Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
  - Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
  - Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
  - Sealing or coating our Products with resin or other coating materials
  - 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
  - Use of the Products in places subject to dew condensation
- The Products are not subject to radiation-proof design.
- Please verify and confirm characteristics of the final or mounted products in using the Products.
- 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.
- De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.
- Confirm that operation temperature is within the specified range described in the product specification.
- 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

- When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
- 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 Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [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.:
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**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.
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