ML9078-002

LSI for power-saving solar power supply control

■ Outline

ML9078-002 is power supply control LSI which performs selection control for a solar cell power supply and a primary battery. This LSI consists of a direct switch circuit and a regulator circuit, and each circuit performs the following operations.

- Direct switch circuit
  - Primary battery side direct switch circuit (BAT_DIRECT)
    - This always compare the primary battery side voltage (V_{BAT}) with the output voltage (VDO) of ML9078-002. In case V_{BAT}>VDO, a primary battery side direct switch will be set to ON and the primary battery side voltage (V_{BAT}) is supplied to the output voltage (VDO).
  - Solar cell side direct switch circuit (SC_DIRECT)
    - This always compare the solar cell side voltage (V_{SC}) with the output voltage (VDO) of ML9078-002. In case V_{SC}>VDO, a solar cell side direct switch will be set to ON and the primary battery side voltage (V_{SC}) is supplied to the output voltage (VDO).

- Regulator circuit
  - The solar cell side voltage (Vsc) will be limited to be 1.5V(typ) or 3.0V(typ).

■ Feature

- Comparison of primary battery power supply voltage (V_{BAT}) and solar cell power supply voltage (V_{SC}) is performed, and the power supply source is selected automatically.
  - When primary battery voltage (V_{BAT}) is higher than solar cell voltage (V_{SC}), it outputs primary battery voltage (V_{BAT}) to the output terminal (VDO) of ML9078-002.
  - When solar cell voltage (V_{SC}) is higher than primary battery voltage (V_{BAT}), it outputs solar cell voltage (V_{SC}) to the output terminal (VDO) of ML9078-002.

- The adverse current from a solar cell to a primary battery is prevented.
  - When primary battery voltage is low, the direct switch by the side of a primary battery turns off. The adverse current to a primary battery from a solar cell is prevented, and the primary battery destruction by the adverse current from a solar cell to a primary battery can be prevented.

- Direct power supply from whether a solar cell output or a primary battery output to the external LSI is available. (at the time of SCREG=L)

- The regulator output voltage is selectable by the external input. (at the time of SCREG=H)
  - In case SCLV=L : regulator output voltage(V_{LD}) will be limited to be 1.5V(typ) (V_{SC}>=2V, I_{SC}<=0.1mA, 25 °C conditions)
  - In case SCLV=H : regulator output voltage(V_{LD}) will be limited to be 3.0V(typ) (V_{SC}>=3.6V, I_{SC}<=0.8mA, 25 °C conditions)

- Low power operation
  - Primary-battery side consumption current: Max 80nA at 25° C
  - SCREG=L,SCLV=X,Solar-cell side consumption current: Max 80nA at 25°C
  - SCREG=H,SCLV=L,Solar-cell side consumption current: Max 250nA at 25°C
  - SCREG=H,SCLV=H,Solar-cell side consumption current: Max 1200 nA at 25°C

- A monitor of the use situation of a solar panel is possible.
  - In case DI_MONI=L, current is supplied from solar cell to external circuit.
  - In case DI_MONI=H, current is supplied from primary battery to external circuit.

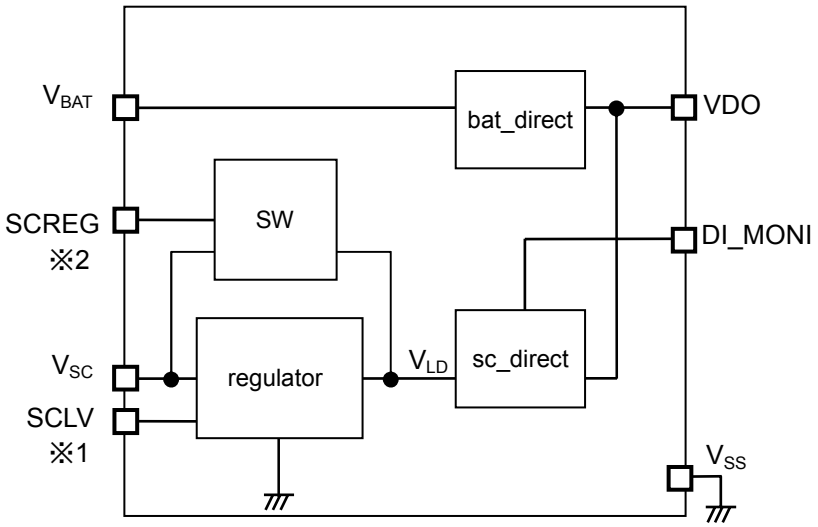
- Shipment form
  - 12-pin plastic WQFN
    - Part number : ML9078-002GDZ05B
  - Chip
    - Part number : ML9078-002WA

- Guaranteed operation range
  - Operating temperature : -20 to +70°C
  - Operating voltage : V_{SC} = 0.0 to 4V, V_{BAT} = 1.1 to 3.6V

■ Block diagram

ML9078-002 block diagram

- The block diagram of ML9078-002 is shown in Fig. 1.

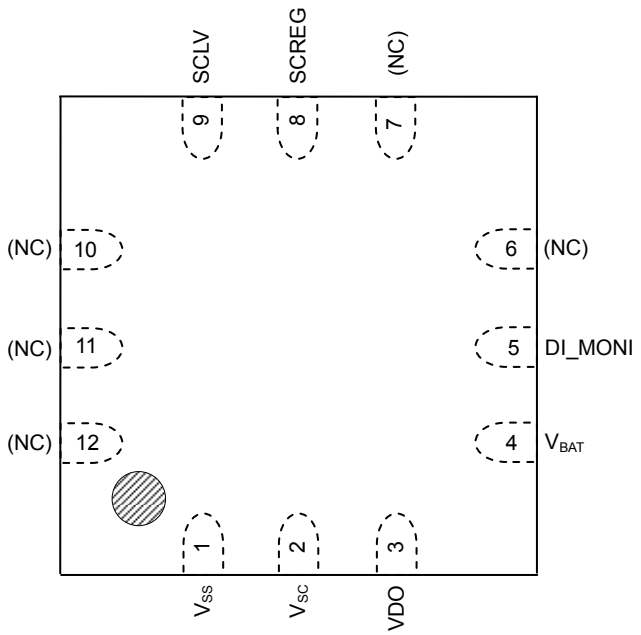


※1 Regulator voltage is chosen to 3.0V or 1.5V by SCLV.
※2 Regulator can be disabled by SCREG through SW.

Fig 1 ML9078-002 block diagram

■ Pin Configuration

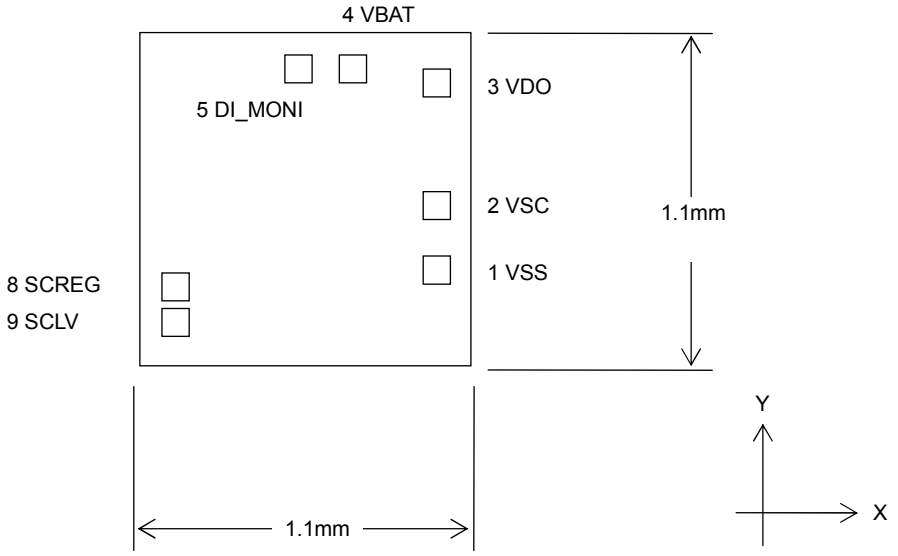
ML9078-002GDZ05B terminal arrangement



(NC): No Connection

Fig. 2 ML9078-002 package article terminal arrangement plan

ML9078-002WA terminal arrangement and outline drawing



Chip size : 1.1mm x 1.1mm
The number of pads : 7 pins
Minimum pad pitch : 120 µm
Pad opening : 90 µm x 90 µm
Chip thickness : 350 µm
The voltage on the back of a chip is V_{SS} level.

Fig. 3 ML9078-002 chip outline drawing

ML9078-002 chip article pad coordinates

Table 1 ML9078-002 pad coordinates table

Chip Center: X=0,Y=0

PAD No.	Pad Name	ML9078-002		PAD No.	Pad Name	ML9078-002	
		X (µm)	Y (µm)			X (µm)	Y (µm)
1	VSS	432.0	-228.0	7	-	-	-
2	VSC	432.0	-21.0	8	SCREG	-432.0	-287.0
3	VDO	432.0	385.0	9	SCLV	-432.0	-407.0
4	VBAT	156.0	432.0	10	-	-	-
5	DI_MONI	-27.0	432.0	11	-	-	-
6	-	-	-	12	-	-	-

■ Terminal explanation

Table 2 Explanation of terminal

Terminal name	I/O	Explanation	Logic
Power supply terminal			
V_{SS}	-	It is the minus side power supply terminal.	-
V_{BAT}	-	It is the primary battery plus side power supply terminal.	-
V_{SC}	-	It is the plus side power supply terminal of a solar power supply. It connects with the plus side of a solar power supply.	-
Regulator setting input terminal			
SCLV	I	It is an input port for a regulator voltage setup. In case SCLV=L, regulator output voltage will be limited to be 1.5V(typ) In case SCLV=H, regulator output voltage will be limited to be 3.0V(typ)	Positive
SCREG	I	It is an input port for an enabling setup of a regulator.	Positive
The output terminal of a primary battery and a solar power supply			
VDO	O	It is an output terminal of a primary battery and a solar power supply.	-
The output terminal which displays power supply source			
DI_MONI	O	It is an output terminal for displaying power supply source. In case DI_MONI=L, current is supplied from solar cell to external ciruit. In case DI_MONI=H, current is supplied from primary battery to external ciruit.	Negative

■ Termination of unused pins

Table 3 shows methods of terminating the unused pins.

Table 3 Termination of unused pins

Terminal	Recommendation terminal processing
output	
VDO	Open
DI_MONI	Open
input	
SCLV(*1)	V_{SC} or V_{SS}
SCREG(*1)	V_{SC} or V_{SS}
* Note Consider input to fix to V_{SC} or V_{SS}.	

■ Electrical property

Absolute maximum rating

(V_{SS}= 0V)

Item	Sign	Conditions	Rated value	Unit
Power supply voltage 1	V_{BAT}	Top = 25 °C	-0.3 to +4.2	V
Power supply voltage 2	V_{SC}	Top = 25 °C	-0.3 to +5.6	V
Power supply voltage 3	VDO	Top = 25 °C	-0.3 to +5.6	V
Input voltage	V_{IN}	Top = 25 °C	- 0.3 to V_{SC}+0.3	V
Output voltage	V_{OUT}	Top = 25 °C	-0.3 to VDO+0.3	V
Output current 1	I_{OUT1}	VDO, Top = 25 °C	10	mA
Permissible loss	PD	Top = 25 °C	0.88	W
Preservation temperature	T_{STG}	-	-40 to +125	°C

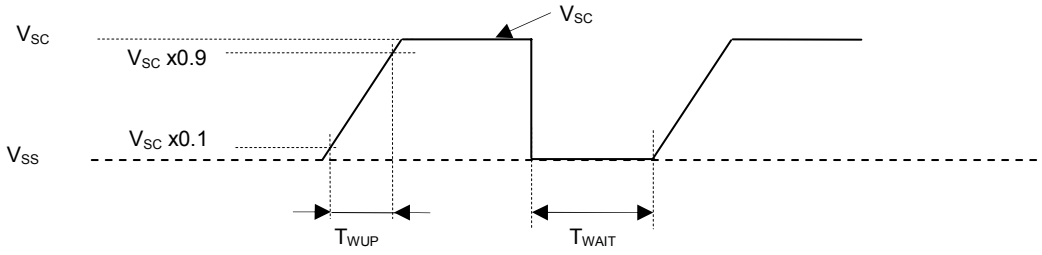
Recommendation operation conditions

(V_{SS}= 0V)

Item	Sign	Conditions		Range	Unit
Temperature of operation	T_{OP}	-		-20 to +70	°C
Voltage of operation	V_{SC} *	Top=-20 to 70		0.0 to 4.0	V
	V_{BAT}	Top=-20 to 70		1.1 to 3.6	
External capacitance for regulator output voltage stabilization	Cdo	Top=-20℃ to 70℃ V_{SC}=0V to 4.0V V_{BAT}=1.1V to 3.6V	SCREG=H SCLV=L	0.01 to 0.1	µF
			SCREG=H SCLV=H	0.1 to 1	µF

* Note
VSC power rise time is required to be more than TWUP=125 us/V.
Please start after stand-by-time TWAIT=10msec when a VSC power supply is less than 0.5V.

Notice of starting speed and stand-by-time for V_{SC}



Direct-current characteristic (Input)

(V_{BAT}=1.1V to 3.6V, V_{SC}=0.0V to 4.0V, V_{SS}=0V, and Top=-20 to +70 °C, unless otherwise specified)

Item	Sign	Conditions	Rating			Unit	Measuring circuit
			Min.	Typ.	Max.		
Input voltage (SCLV, SCREG)	VIH	V_{SC}=1.1 to 4.0V	0.7 xV_{SC}	-	V_{SC}	V	1
	VIL	V_{SC}=1.3 to 4.0V	0	-	0.3 xV_{SC}		
		V_{SC}=1.1 to 4.0V	0	-	0.2 xV_{SC}		
Input (SCLV, SCREG)	IIH	V_{SC}=1.1 to 4.0V	-	-	10	nA	
	IIL	V_{SC}=1.1 to 4.0V	-10	-	-		

.

Direct-current characteristic (power supply control)

(V_{BAT}=1.1V to 3.6V, V_{SC}=0.0V to 4.0V, V_{SS}=0V, and Top=-20 to +70 °C, unless otherwise specified)

Item	Sign	Conditions		Standard value			Unit	Measuring Circuit
				Min.	Typ.	Max.		
Primary battery side Consumption current	IDD_{BAT}(*1)	V_{BAT}=3.6V Top = 25 °C		-	-	80	nA	2
Solar power supply side Consumption current	IDD_{SC}(*2)	V_{SC}=4V Top = 25 °C	SCREG=L	-	-	80		
		V_{SC}=4V Top = 25 °C	SCREG=H SCLV=L	-	-	250		
		V_{SC}=4V Top = 25 °C	SCREG=H SCLV=H	-	-	1200		

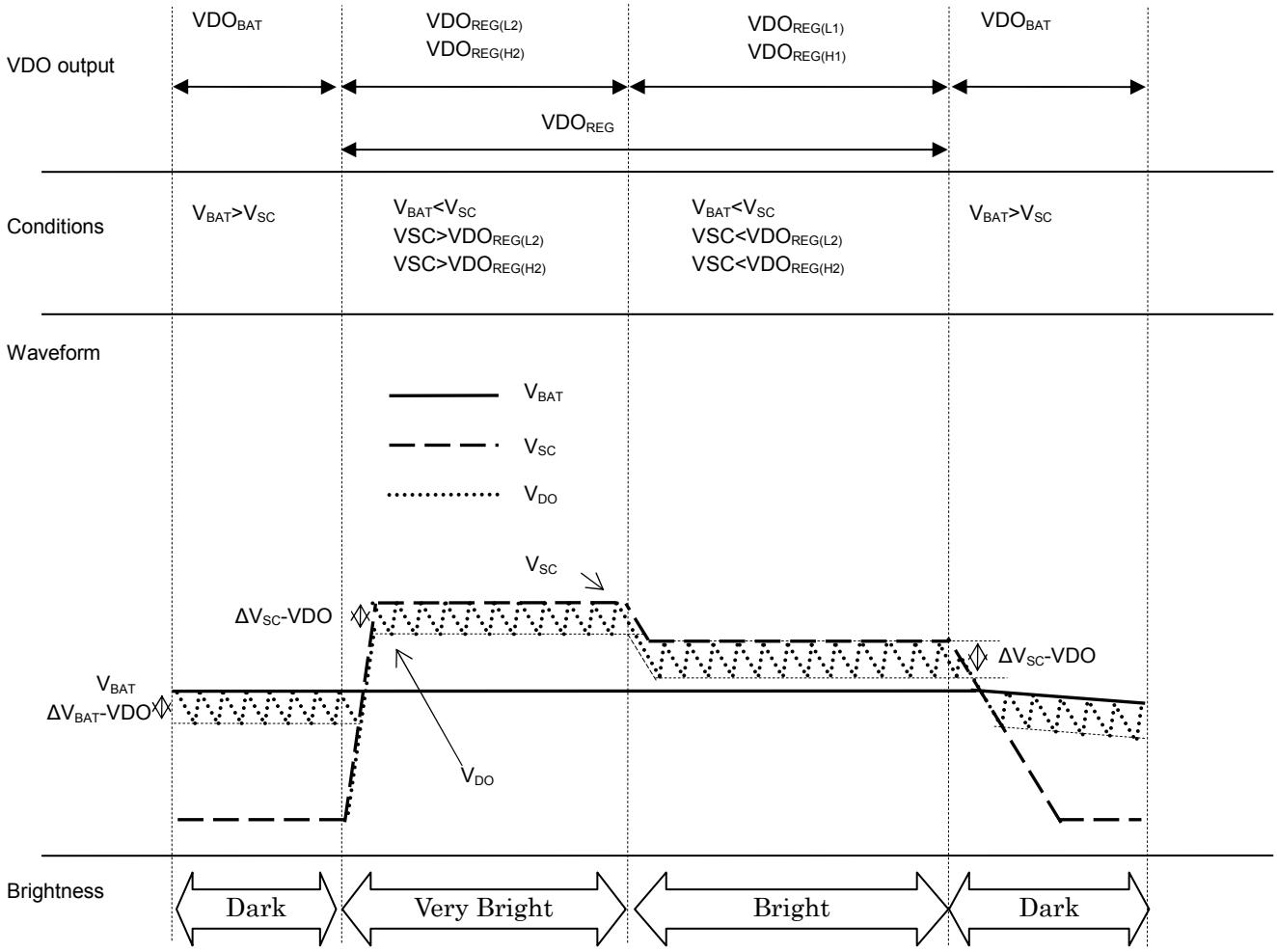
*1 : IDD_{BAT} is consumption current to the current consumed by the primary battery side.

*2 : IDD_{SC} is consumption current to the current consumed by the solar power supply side.

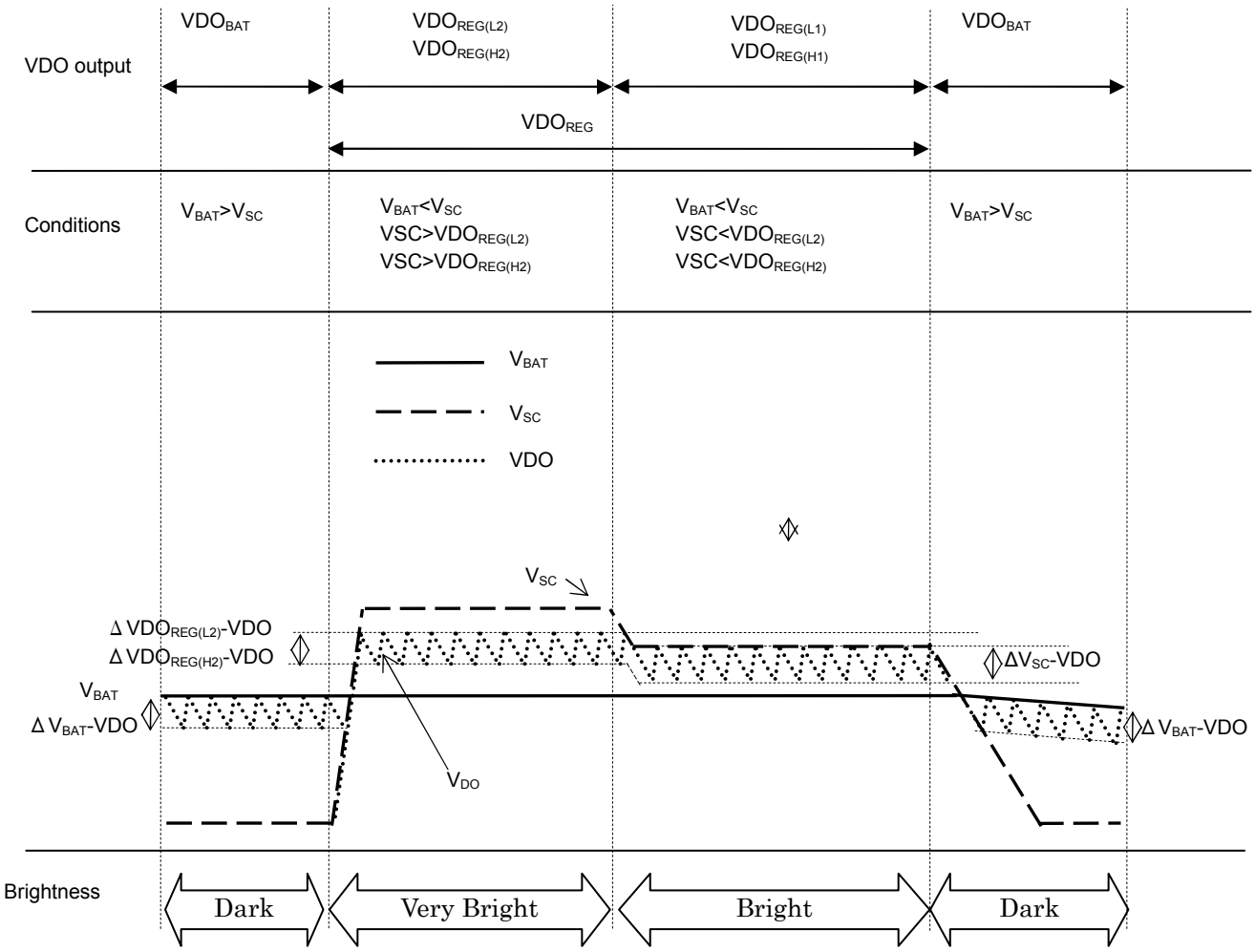
(V_{BAT}=1.1V to 3.6V, V_{SC}=0.0V to 4.0V, V_{SS}=0V, and Top=-20 to +70 °C, unless otherwise specified)

Item	Sign	Conditions		Standard value			Unit	Measuring Circuit
				Min.	Typ.	Max.		
VDO voltage V_{BAT}->VDO (VDO is supplied from V_{BAT})	VDO_{BAT}	$V_{SC}<V_{BAT}$ - 50mV 0V<=V_{BAT}<=1.1V I_{BAT}<=2mA		0	-	-	V	3,4
		$V_{SC}<V_{BAT}$ - 50mV 1.1V<=V_{BAT}<=2V I_{BAT}<=2mA		V_{BAT} - 0.3	-	-		
		$V_{SC}<V_{BAT}$ - 50mV V_{BAT}>2.0V I_{BAT}<=2mA		V_{BAT} - 0.15	-	-		
VDO voltage V_{SC} (VDO) (VDO is supplied from V_{SC}) Regulator through mode	VDO_{SC}	$V_{SC}>V_{BAT}$ - 50mV 0V<=V_{SC}<=1.1V I_{SC}<=2mA	SCREG=L	0	-	-		
		$V_{SC}>V_{BAT}$ - 50mV 1.1V<=V_{SC}<=2V I_{SC}<=2mA		V_{SC} - 0.3	-	-		
		$V_{SC}>V_{BAT}$ - 50mV V_{SC}>2.0V I_{SC}<=2mA		V_{SC} - 0.13	-	-		
VDO voltage V_{SC} (VDO) (VDO is supplied from V_{SC}) Regulator operational mode	$VDO_{REG(L1)}$	$V_{SC}>V_{BAT}$ - 50mV 0V<=V_{SC}<=1.1V I_{SC}<=0.1mA Cdo=0.1uF Top = 25 °C	SCREG=H SCLV=L	0	-	-		
		$V_{SC}>V_{BAT}$ - 50mV 1.1V<=V_{SC}<=2V I_{SC}<=0.1mA Cdo=0.1uF Top = 25 °C		0.8	-	1.6		
	$VDO_{REG(L2)}$	$V_{SC}>V_{BAT}$ - 50mV V_{SC}>2V I_{SC}<=0.1mA Cdo=0.1uF Top = 25 °C		1.35	1.5	1.6		
	$VDO_{REG(H1)}$	$V_{SC}>V_{BAT}$ - 50mV 0V<=V_{SC}<=1.1V I_{SC}<=0.8mA Cdo=0.1uF Top = 25 °C	SCREG=H SCLV=H	0	-	-		
		$V_{SC}>V_{BAT}$ - 50mV 1.1V<=V_{SC}<=3.6V I_{SC}<=0.8mA Cdo=0.1uF Top = 25 °C		0.8	-	3.1		
	$VDO_{REG(H2)}$	$V_{SC}>V_{BAT}$ - 50mV V_{SC}>3.6V I_{SC}<=0.8mA Cdo=0.1uF Top = 25 °C		2.9	3	3.1		

- ML9078-002 operation in regulator through mode



- ML9078-002 operation in regulator mode



Direct-current characteristic (DI_MONI)

(V_{BAT}=1.1V to 3.6V, V_{SC}=0.0V to 4V, V_{SS}=0V, and Top=-20 to +70 °C, unless otherwise specified)

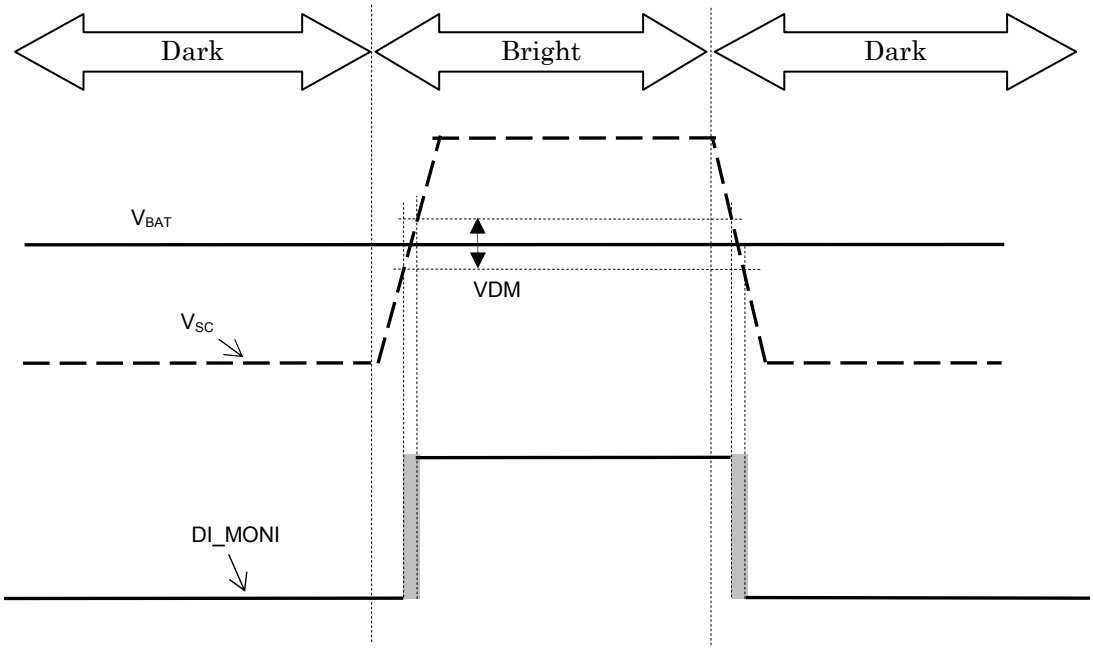
Item	Sign	Conditions	Standard value			Unit	Measuring Circuit
			Min.	Typ.	Max.		
Output voltage 1 (DI_MONI)	VOH1	IOH1=-0.5mA V_{DO}=1.8V ~ 4.0V	V_{SC} 0.7	-	-	V	5
		IOH1=-0.1mA V_{DO}=1.3V ~ 4.0V	V_{SC} 0.5	-	-		
		IOH1=-0.03mA V_{DO}= 1.1V ~ 4.0V	V_{SC} 0.5	-	-		
	VOL1	IOL1=+0.5mA V_{DO}=1.8V ~ 3.6V	-	-	0.7	V	6
		IOL1=+0.1mA V_{DO}=1.3V ~ 3.6V	-	-	0.7		
		IOL1=+0.03mA V_{DO}=1.1V ~ 3.6V	-	-	0.5		

Alternating-current characteristic (DI_MONI)

(V_{BAT}=1.1V to 3.6V, V_{SC}=0.0V to 4V, V_{SS}=0V, and Top=-20 to +70 °C, unless otherwise specified)

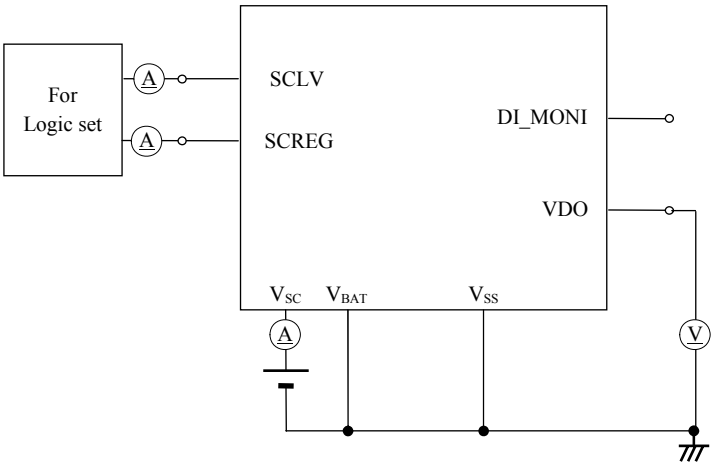
Item	Sign	Conditions	Standard value			Unit	Measuring Circuit
			Min.	Typ.	Max.		
DI_MONI Detection voltage	VDM	Top = 25 °C	V_{BAT} -0.1	V_{BAT}	V_{BAT} +0.1	V	5

Operation of DI_MONI

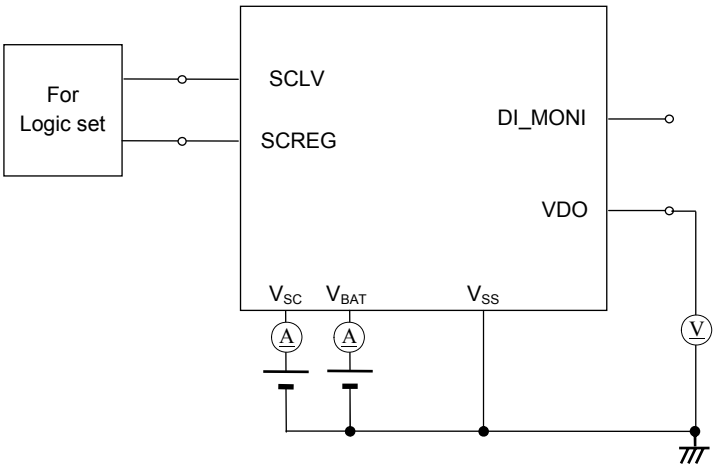


■ Measuring circuit

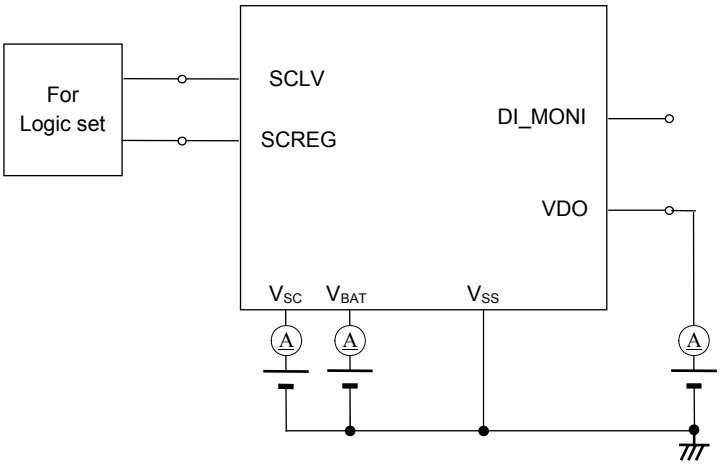
- Measuring circuit 1



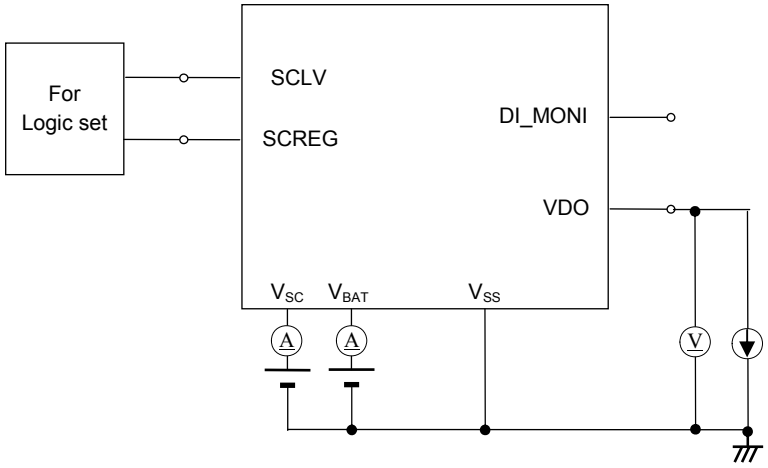
- Measuring circuit 2



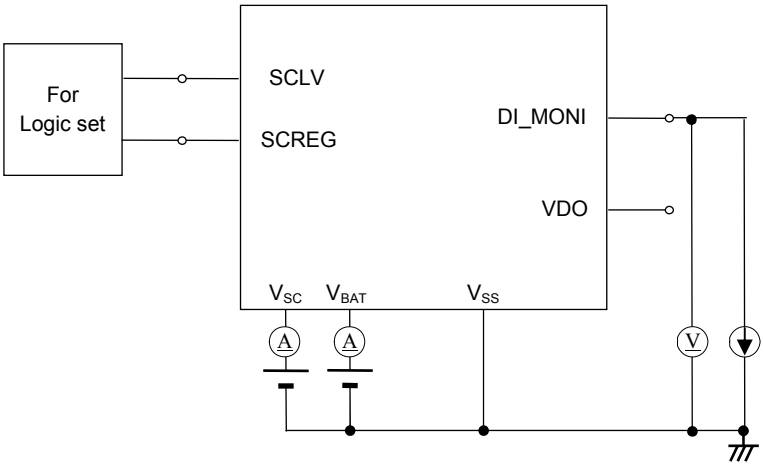
- Measuring circuit 3



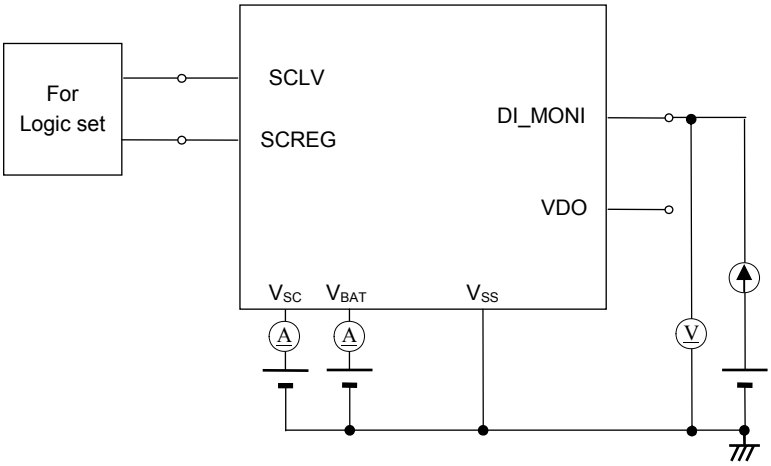
- Measuring circuit 4



- Measuring circuit 5

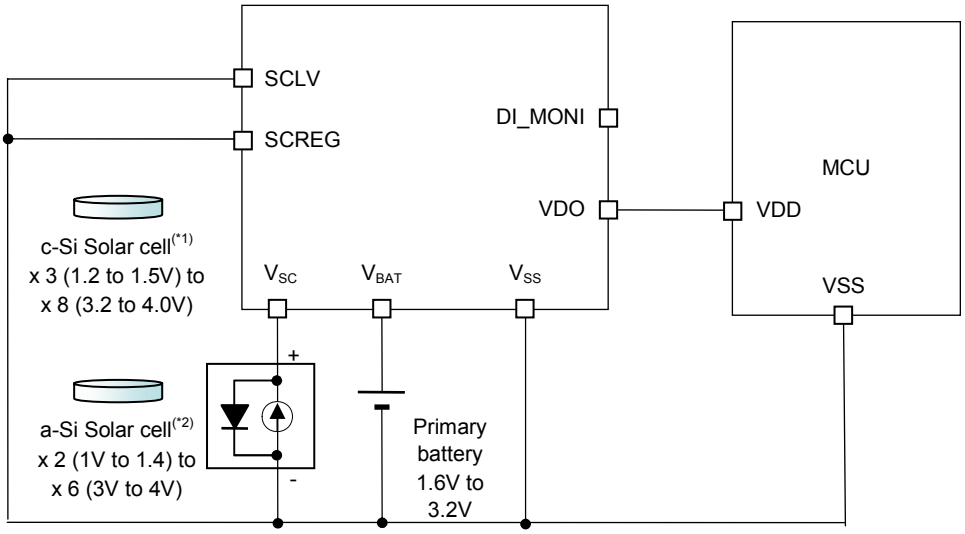


- Measuring circuit 6

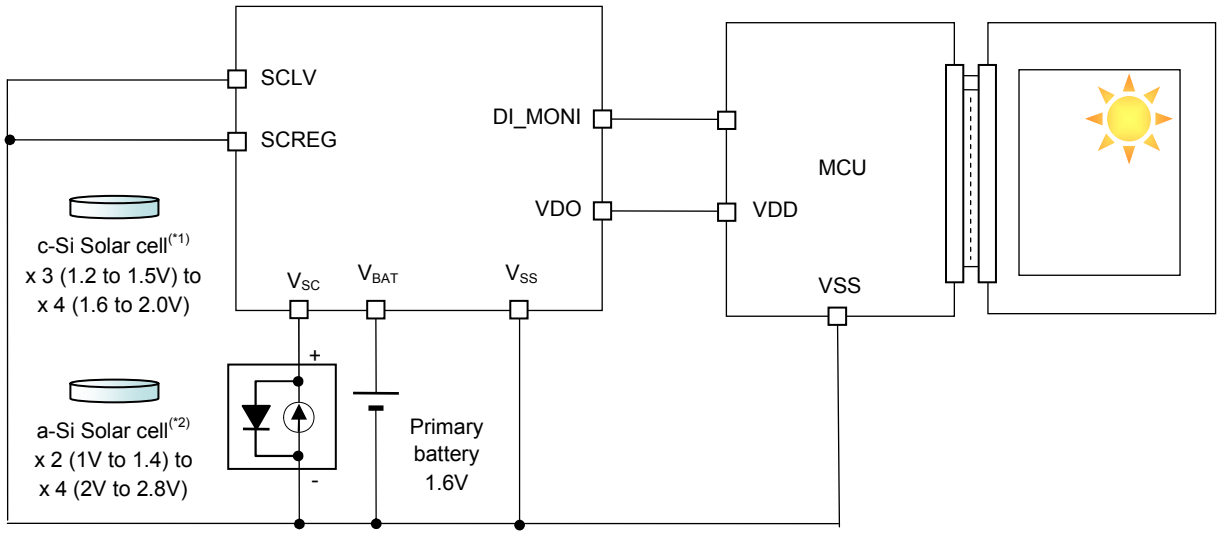


■ Appllilcation circuit

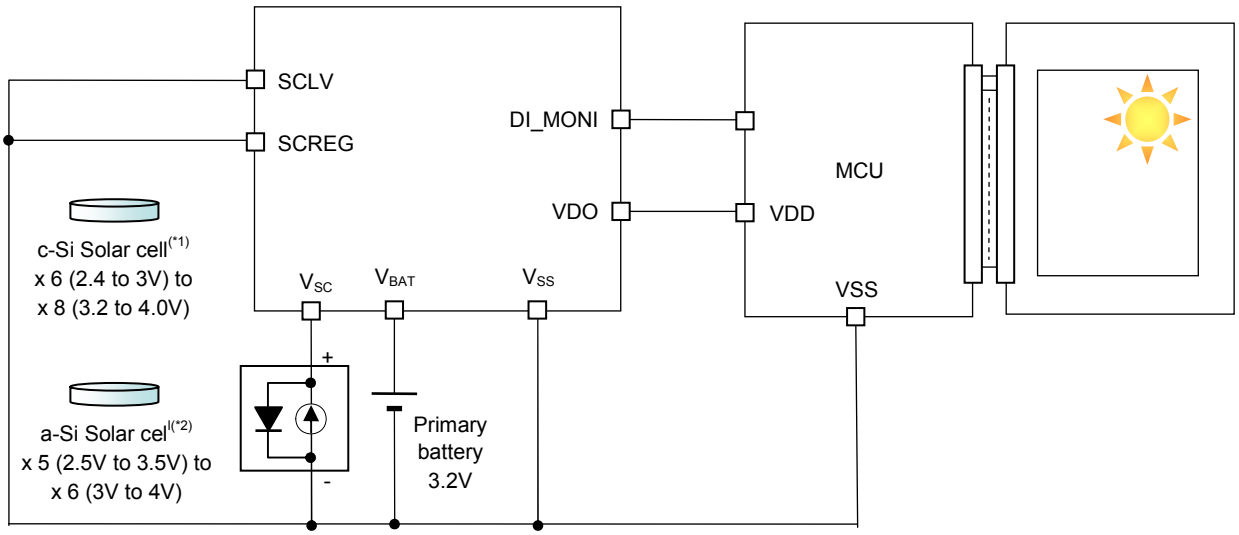
- Simple application
  - SCLV=L, SCREG=L



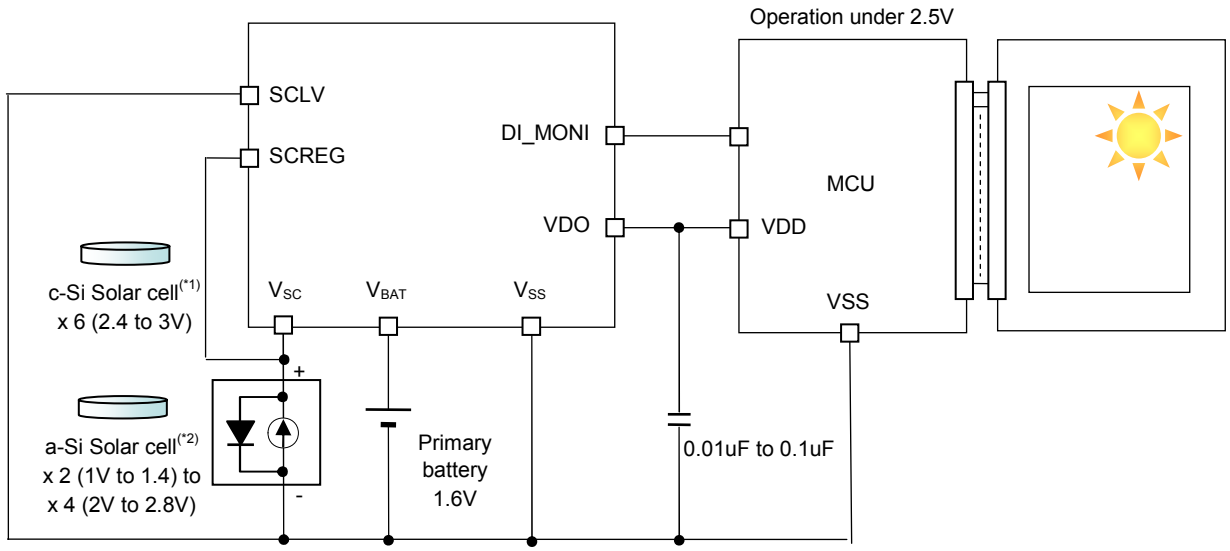
- When DI_MONI is used (1.5V battery)
  - SCLV=L, SCREG=L



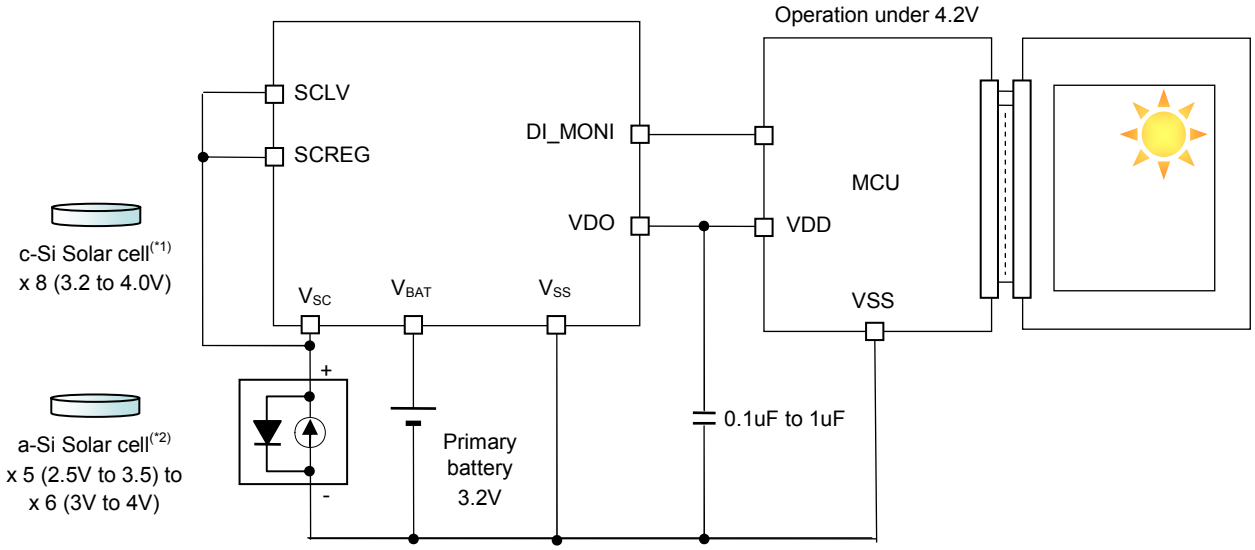
- When DI_MONI is used (3V battery)
  - SCLV=L, SCREG=L



- When a regulator is used (regulator voltage will be at 1.65 V)
  - SCLV=L, SCREG=H
  - When using a regulator by SCLV=L, please insert the external capacitance Cdo = 0.01uF to 0.1uF between VDO and V_{SS} for regulator output voltage stabilization.



- When a regulator is used (regulator voltage will be at 3.3 V
  - SCLV=H, SCREG=H
  - When using a regulator by SCLV=H, please insert the external capacitance Cdo = 0.1uF to 1uF between VDO and V_{SS} for regulator output voltage stbirization.

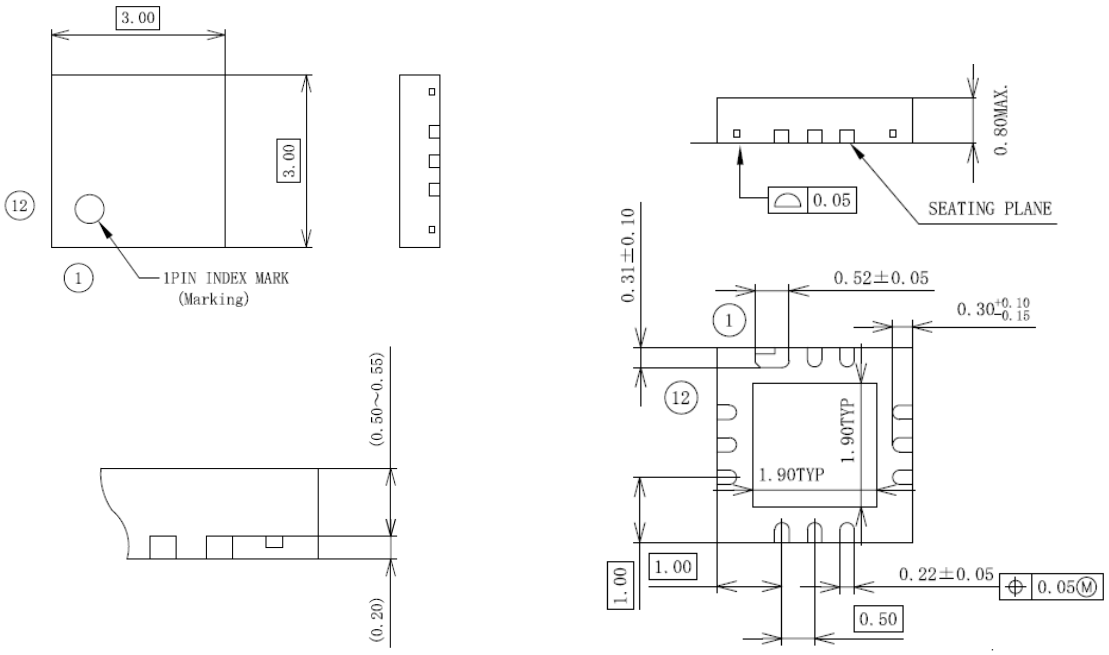


*1 : c-Si Solar cell is a Crystal Si type solar cell. (The single crystal Si, the many crystals Si)
*2 : a-Si Solar cell is an amorphous Si type solar cell. (Amorphous silicon)

■ Package dimensions

(Unit: mm)

P-WQFN12-0303-0.50-63



Package material	Epoxy resin
Lead frame material	Cu alloy
Lead finish	Ni/Pd/Au
Solder thickness	Au/Pd Max0.01/Max0.15
Package weight (g)	0.01980typ.
Rev. No./Last Revised	3 / Oct. 07,2010

LAPIS Semiconductor Co.,Ltd.

Attention on surface mount type package mounting

A surface mount type package is a package which is very much easy to receive influence in the heat at the time of reflow mounting, the amount of moisture absorption of the package at the time of storage, etc.
Therefore, when inquired by implementation of reflow mounting, please be sure to ask the product name, a package name, the number of pins, a package code and the mounting conditions (the reflow method, temperature, number of times) for which it wishes, storage conditions, etc. to the business assigned to our company.

■ Revision history

Document No.	Date of issue	Page		The contents of change
		Before revision	After revision	
FEDL9078-002-01	Jan.30,2012	-	-	First edition issue

NOTES

No copying or reproduction of this document, in part or in whole, is permitted without the consent of LAPIS Semiconductor Co., Ltd.
The content specified herein is subject to change for improvement without notice.
The content specified herein is for the purpose of introducing LAPIS Semiconductor's products (hereinafter "Products"). If you wish to use any such Product, please be sure to refer to the specifications, which can be obtained from LAPIS Semiconductor upon request.
Examples of application circuits, circuit constants and any other information contained herein illustrate the standard usage and operations of the Products. The peripheral conditions must be taken into account when designing circuits for mass production.
Great care was taken in ensuring the accuracy of the information specified in this document. However, should you incur any damage arising from any inaccuracy or misprint of such information, LAPIS Semiconductor shall bear no responsibility for such damage.
The technical information specified herein is intended only to show the typical functions of and examples of application circuits for the Products. LAPIS Semiconductor does not grant you, explicitly or implicitly, any license to use or exercise intellectual property or other rights held by LAPIS Semiconductor and other parties. LAPIS Semiconductor shall bear no responsibility whatsoever for any dispute arising from the use of such technical information.
The Products specified in this document are intended to be used with general-use electronic equipment or devices (such as audio visual equipment, office-automation equipment, communication devices, electronic appliances and amusement devices).
The Products specified in this document are not designed to be radiation tolerant.
While LAPIS Semiconductor always makes efforts to enhance the quality and reliability of its Products, a Product may fail or malfunction for a variety of reasons.
Please be sure to implement in your equipment using the Products safety measures to guard against the possibility of physical injury, fire or any other damage caused in the event of the failure of any Product, such as derating, redundancy, fire control and fail-safe designs. LAPIS Semiconductor shall bear no responsibility whatsoever for your use of any Product outside of the prescribed scope or not in accordance with the instruction manual.
The Products are not designed or manufactured to be used with any equipment, device or system which requires an extremely high level of reliability the failure or malfunction of which may result in a direct threat to human life or create a risk of human injury (such as a medical instrument, transportation equipment, aerospace machinery, nuclear-reactor controller, fuel-controller or other safety device). LAPIS Semiconductor shall bear no responsibility in any way for use of any of the Products for the above special purposes. If a Product is intended to be used for any such special purpose, please contact a ROHM sales representative before purchasing.
If you intend to export or ship overseas any Product or technology specified herein that may be controlled under the Foreign Exchange and the Foreign Trade Law, you will be required to obtain a license or permit under the Law.