FEDL9077-02
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ML9077

Power-saving solar power supply control LSI

GENERAL DESCRIPTION

ML9077 controls charging a solar power current to a rechargeable battery.
The control circuit is consists of a overcharge prevention circuit, a charge control circuit and a rechargeable battery voltage monitor circuit. Each circuit performs following operation.

- Overcharge prevention circuit
  When a rechargeable battery becomes FULL charge state, the current of solar cell is drawn to VSS and the charge current for the rechargeable battery is omitted so that rechargeable battery voltage does not rise any more.
- Charge control circuit
  The voltage of solar cell (VSC) is always compared to the voltage of rechargeable battery (VBAT) and it will have starting to charge the battery if VSC＞VBAT, and stop to charge if VSC≦BAT.
- Rechargeable battery voltage monitor circuit（BOD : Brown-Out Detector）
  The voltage of rechargeable battery (VBAT) is always supervised, and it controls VBAT low voltage detection signal (VBOD) and rechargeable battery voltage output (VDO).

FEATURES

- Self control the solar cell current for charging a rechargeable battery.

- Direct charge solar cell current (ISC) to a rechargeable battery.
  – [VSC＞2.0V, ISC≦1mA conditions]: Potential difference=Max 0.1V（VSC-VBAT）
  – [VSC＞2.0V, ISC≦1mA conditions]: Potential difference=Max 2.0V（VSC-VBAT）

- 2 Selectable overcharge prevention voltage.

- 2 Selectable low voltage detection voltage.

- Power supply system detects a low voltage of rechargeable battery and power off a external microcomputer.

- Low power operation
  – Solar cell current : 80nA
  – Rechargeable battery current : 80nA

- Shipment
  – 12-pin plastic WQFN
    Part number: ML9077GDZ05B
  – Chip
    Part number: ML9077WA

- Guaranteed operating range
  – Operating temperature: –20°C to 70°C
  – Operating voltage: V_{SC} = 0.0V to 3.6V, V_{BAT} = 0.0V to 3.2V

BLOCK DIAGRAM
ML9077 Block Diagram

Figure 1 shows ML9077 block diagram.

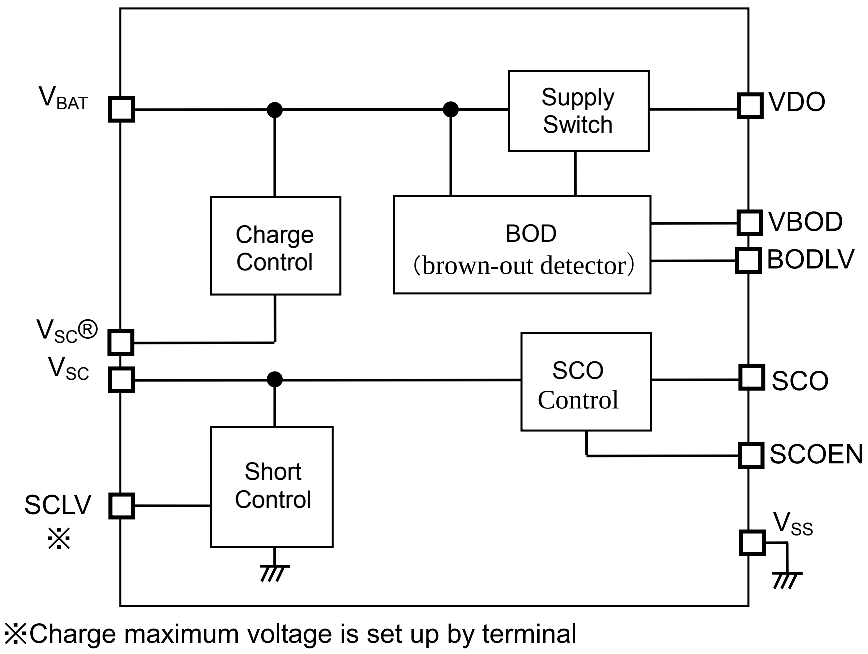
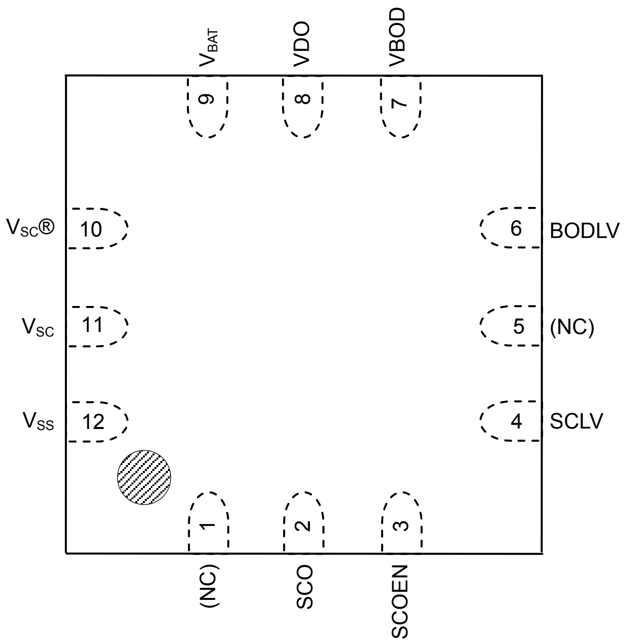


Figure 1 ML9077 Block Diagram

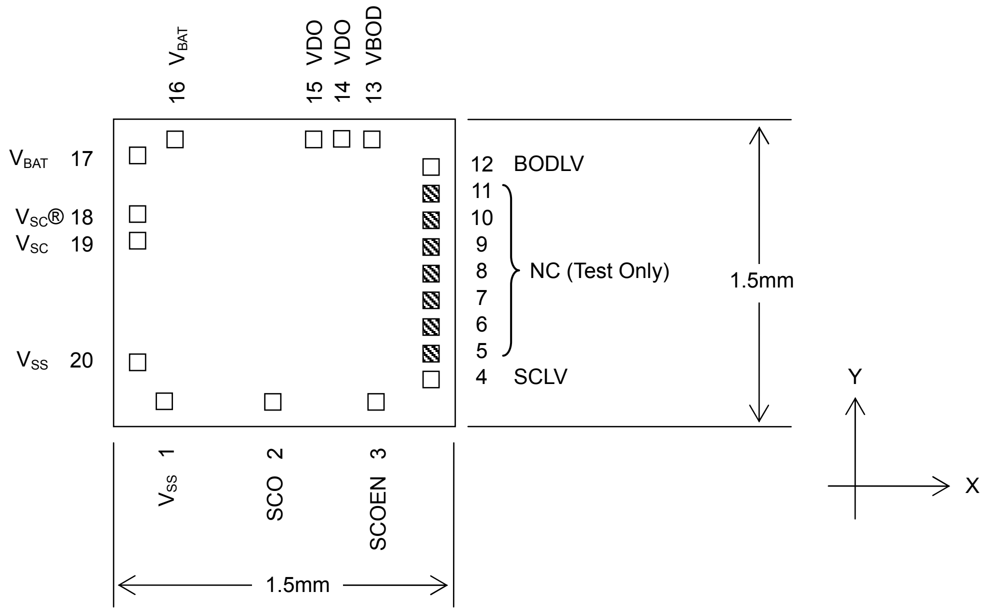
PIN CONFIGURATION
ML9077 WQFN12 Pin Layout



(NC): No Connection

Figure 2 ML9077 WQFN12 Pin Configuration

ML9077 Chip Pin Layout & Dimension



(NC): No Connection

[Note]
There may be some causions for assembly condition (To Be Noted)

Chip size:	1.5mm×1.5mm
PAD count:	20 pins（Test Only PAD count：7pins）
Minimum PAD pitch:	120 µm
PAD aperture:	90 µm × 90 µm
Chip thickness:	350 µm
Voltage of the rear side of chip:	V_{SS} level

Figure 3 ML9077 Chip Layout & Dimension

ML9077 Pad Coordinates

Table 1 ML9077 Pad Coordinates

Chip Center: X=0,Y=0

PAD No.	Pad Name	ML9077	
		X (µm)	Y (µm)
1	VSS	-442.0	-632.0
2	SCO	-94.0	-632.0
3	SCOEN	337.0	-632.0
4	SCLV	632.0	-565.0
5	NC	632.0	-445.0
6	NC	632.0	-325.0
7	NC	632.0	-205.0
8	NC	632.0	-85.0
9	NC	632.0	35.0
10	NC	632.0	155.0

PAD No.	Pad Name	ML9077	
		X (µm)	Y (µm)
11	NC	632.0	275.0
12	BODLV	632.0	395.0
13	VBOD	484.0	632.0
14	VDO	364.0	632.0
15		244.0	632.0
16	VBAT	-479.0	632.0
17		-632.0	534.0
18	VSC®	-632.0	275.0
19	VSC	-632.0	155.0
20	VSS	-632.0	-532.0

[Note]
※The following PADs is the same signal, please bonding it to one of PAD.
PAD No. 1 and 20、PAD No. 14 and 15、PAD No. 16 and 17
※The directions for VSC®.
When charging current limitation resistance is required, it connects with VSC through resistance, please short to VSC ex cept it.

PIN DESCRIPTION

Pin name	I/O	Description	Logic
Power supply			
V_{SS}	—	Negative power supply pin	—
V_{BAT}	—	Rechargeable battery positive power supply pin	—
V_{SC}	—	Solar cell positive power supply pin	—
V_{SC}®	—	Solar cell positive power supply pin to have a charging current limitation resistor. When the charge current limitation is needed for a solar panel, connect the positive power(+) of solar panel to VSC pin and connect the positive power(+) to VSC® through the current limitation register. When the charge current limitation is Not needed for a solar panel, connect the positive power(+) of solar panel to both VSC pin and VSC® pin.	—
Solar current monitor terminal			
SCOEN	I	Solar current monitor enable pin	Positive
SCO	O	Output for solar current monitor	—
BOD voltage setting input			
BODLV		Brown-out detector voltage select pin	Positive
Fault charge detection voltage setting input			
SCLV	I	Overcharge prevention voltage select pin	Positive
BOD output terminal			
VBOD	O	Brown-out detector output for rechargeable battery low voltage	—
Rechargeable battery output			
VDO	O	Rechargeable battery voltage output	—

TERMINATION OF UNUSED PINS

Table 3 shows methods of terminating the unused pins.

Table 3 Termination of Unused Pins

Pin	Recommended pin termination
VDO	Open
VBOD	Open
BODLV	V_{BAT} or V_{SS}
SCLV	V_{BAT} or V_{SS}
SCOEN	Open
SCO	Open

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

(V_{SS}= 0V)

Parameter	Symbol	Condition	Rating	Unit
Power supply voltage 1	V_{BAT}	Ta=25℃	-0.3 to +3.7	V
Power supply voltage 2	V_{SC}	Ta=25℃	-0.3 to +3.7	V
Power supply voltage 3	VDO	Ta=25℃	-0.3 to +3.7	V
Input voltage	V_{IN}	Ta=25℃	-0.3 to V_{BAT}+0.3	V
Output voltage	V_{OUT}	Ta=25℃	-0.3 to V_{BAT}+0.3	V
Output current 1	I_{OUT1}	VDO、Ta=25℃	30	mA
Output current 2	I_{OUT2}	VBOD、Ta=25℃	-4 to +4	mA
Power dissipation	PD	Ta=25℃	0.88	W
Storage temperature	T_{STG}	—	-40 to +125	℃

RECOMMENDED OPERATING CONDITIONS

(V_{SS}= 0V)

Parameter	Symbol	Condition	Range	Unit
Operating temperature	T_{OP}	-	-20 to +70	℃
Operating voltage	V_{SC}	Tj=-20℃to 70℃	0.0 to 3.6	V
	V_{BAT}		0.0 to 3.2	

DC CHARACTERISTICS (Input)

(V_{BAT}=1.1 to 3.6V, V_{SS}=0V, Ta=-20 to +70℃ unless otherwise specified)

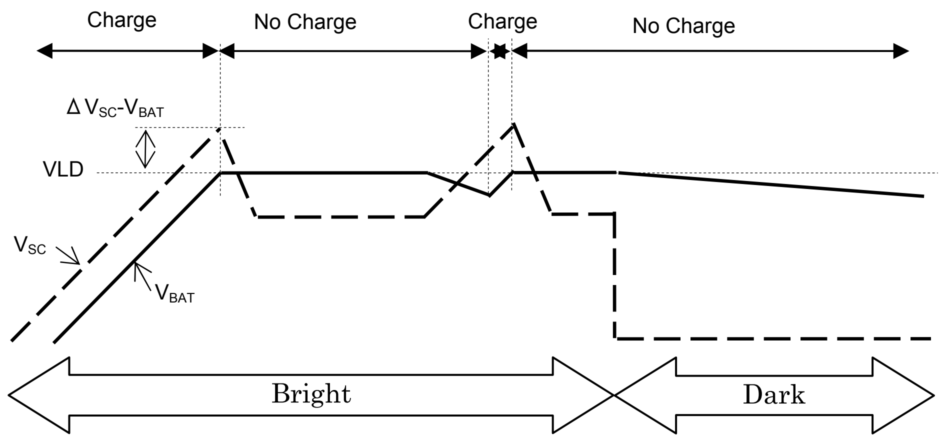
Parameter	Symbol	Condition	Rating			Unit	Measuring circuit
			Min.	Typ.	Max.		
Input voltage (BODLV,SCLV) (SCOEN)	VIH	V_{BAT}=1.3 to 3.6V	0.7 ×V_{BAT}	—	V_{BAT}	V	1
		V_{BAT}=1.1 to 3.6V	0.7 ×V_{BAT}	—	V_{BAT}		
	VIL	V_{BAT}=1.3 to 3.6V	0	—	0.3 ×V_{BAT}		
		V_{BAT}=1.1 to 3.6V	0	—	0.2 ×V_{BAT}		
Input current (SCOEN)	IIH	VIH=V_{BAT}	—	—	0.1	μA	2
	IIL	VIL=0V	-0.1	—	—		

DC CHARACTERISTICS (Charge control)

(V_{BAT}=1.1 to 3.6V, V_{SS}=0V, Ta=-20 to +70℃ unless otherwise specified)

Parameter	Symbol	Condition		Rating Min.	Typ.	Max.	Unit	Measuring circuit
Overcharge non-prevention *[1](V_{BAT})	VSCL	I_{SC}≦150nA,Ta=-20 to +70℃		1.05	—	—	V	1
Overcharge prevention voltage (V_{BAT}) (Rechargeable battery clamp voltage)	VLD	I_{SC}=0.15uA~ 6mA Ta=25℃	SCLV="H"	3.0	—	3.2	V	1
			SCLV="L"	2.5	—	2.7	V	1
Overcharge prevention voltage Temperature characteristics	T_{VLD}	Ta=-20℃ to 70℃		-1.2	—	1.2	mV/℃	1
Supply current (V_{SC})	IDD_{SC}	V_{BAT}=VLD(min),V_{SC}=V_{BAT}-0.05V Ta=25℃		—	—	80	nA	1
Potential difference (V_{SC}-V_{BAT})	Δ V_{SC}-V_{BAT}	V_{SC}>2.0V, ISC≦1mA		—	—	0.1	V	1
		V_{SC}≦2.0V, ISC≦1mA		—	—	2	V	1

*[1] : The overcharge prevention circuit does not work when the solar panel voltage (V_{SC}) is less than 1.05V even if the rechargeable battery becomes FULL charge state.



DC CHARACTERISTICS (Solar current monitor)

(V_{BAT}=1.1 to 3.6V, V_{SS}=0V, Ta=-20 to +70℃ unless otherwise specified)

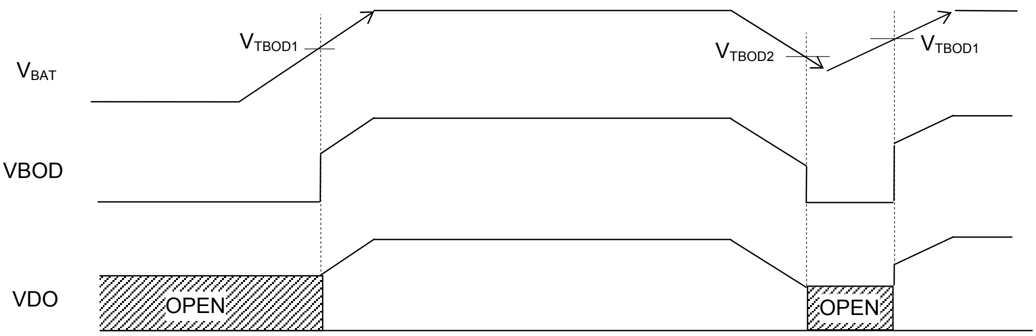
Parameter	Symbol	Condition	Rating Min.	Typ.	Max.	Unit	Measuring circuit
Output current (SCO)	ISCO1	V_{SC}=1.2V, SCO=1.1V, SCOEN="H"	—	—	-10	μA	2
	ISCO2	V_{SC}=3.4V, SCO=0V, SCOEN="L"	-0.05	—	—	μA	2

DC CHARACTERISTICS (Brown-out detection)

(V_{BAT}=1.1 to 3.6V, V_{SS}=0V, Ta=-20 to +70℃ unless otherwise specified)

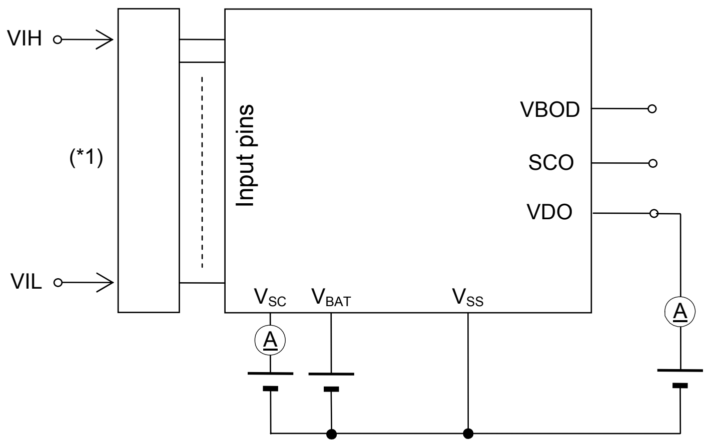
Parameter	Symbol	Condition		Rating Min.	Rating Typ.	Rating Max.	Unit	Measuring circuit
Reversal voltage (BOD) *1	V_{TBOD1}	V_{BAT}="L"⇒"H"	BODLV="L"	1.0	1.15	1.25	V	3
			BODLV="H"	1.7	1.8	1.9		
	V_{TBOD2}	V_{BAT}="H"⇒"L"		V_{TBOD1} -0.25	—	V_{TBOD1} -0.1		
Temperature characteristics (BOD)	T_{BOD}	In the state of reversal voltage Ta=-20℃～60℃		-1.5	—	1.5	mV/℃	
Supply current (V_{BAT})	IDD_{BAT}	-		—	—	80	nA	
Output voltage (VBOD)	VOH1	IOH1=-0.5mA, V_{BAT}=1.8～3.6V		V_{BAT} -0.5	—	—	V	
		IOH1=-0.1mA, V_{BAT}=1.3～3.6V		V_{BAT} -0.3	—	—		
		IOH1=-0.03mA, V_{BAT}=1.1 to 3.6V		V_{BAT} -0.3				
	VOL1	IOL1=+0.5mA, V_{BAT}=1.8 to 3.6V		—	—	0.5		
		IOL1=+0.1mA, V_{BAT}=1.3 to 3.6V		—	—	0.5		
		IOL1=+0.03mA, V_{BAT}=1.1 to 3.6V				0.3		
Output current (VDO)	IVDO1	V_{BAT}=V_{TBOD1}~1.8V, VDO=V_{BAT}-0.05V		—	—	-5	mA	
	IVDO2	V_{BAT}=1.8~3.6V, VDO=V_{BAT}-0.05V		—	—	-20		
	IVDO3	V_{BAT}=0.0~V_{TBOD1}, VDO=0.0~V_{BAT}		-0.05	—	—	μA	

*1 : If VBAT voltage turns into below BOD reversal voltage, a VBOD output will serve as a VSS level, if a VDO terminal will be in an open state and VBAT voltage becomes more than BOD reversal voltage, a VBOD output will serve as a VBAT level and a VBAT level will be outputted from a VDO terminal.



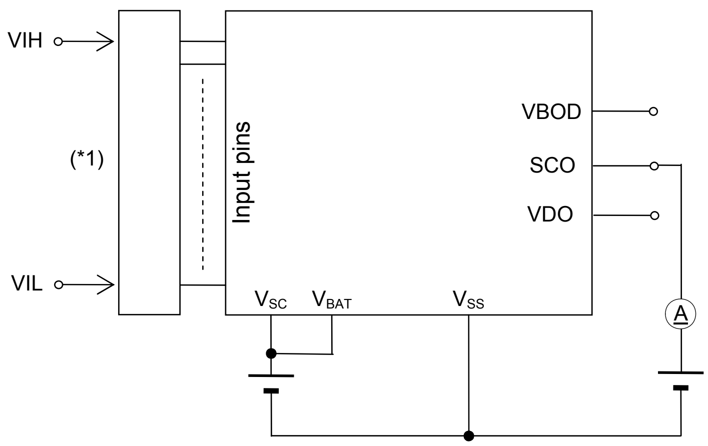
MEASURING CIRCUITS

MEASURING CIRCUIT 1



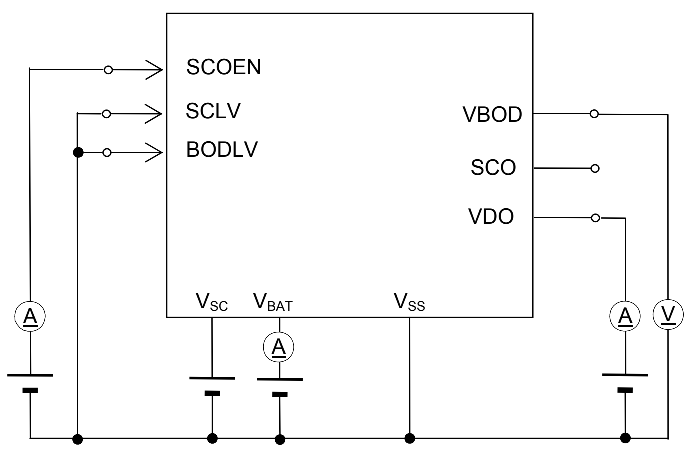
(*1) Input logic circuit to determine the specified measuring conditions.

MEASURING CIRCUIT 2



(*1) Input logic circuit to determine the specified measuring conditions.

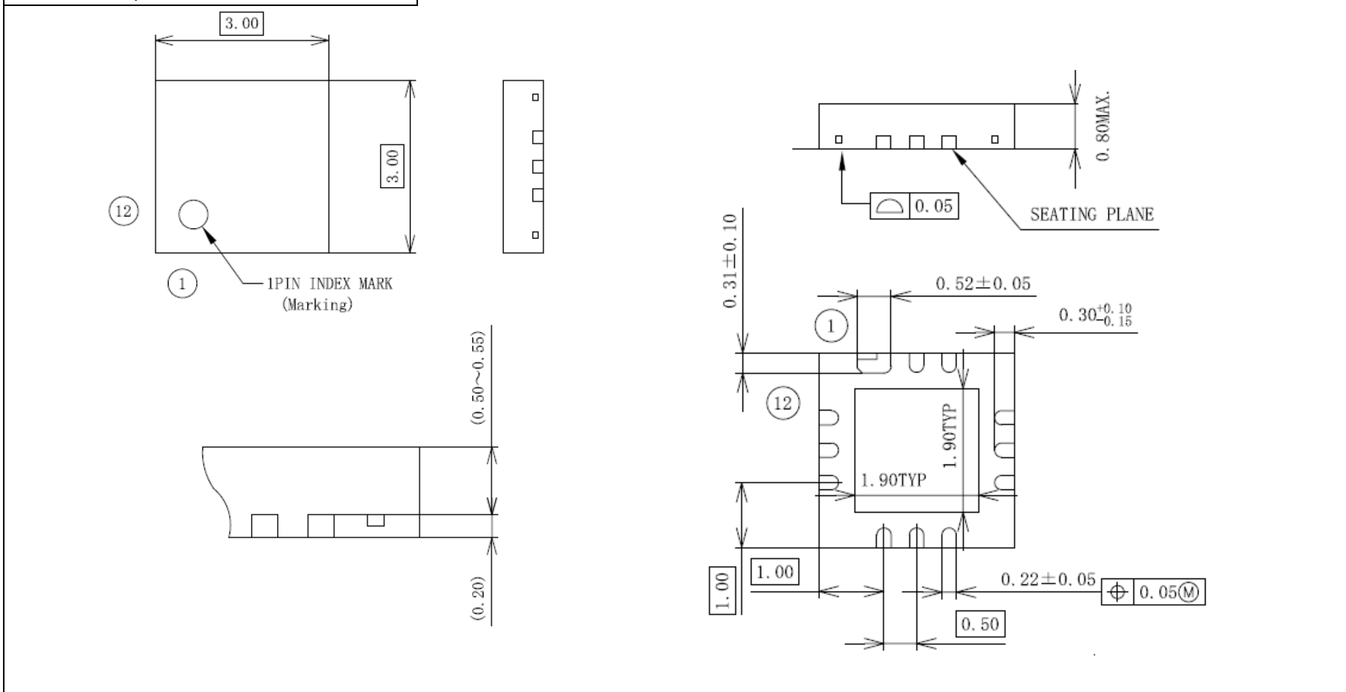
MEASURING CIRCUIT 3



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

Notes for Mounting the Surface Mount Type Package

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact our responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

REVISION HISTORY

Document No.	Date	Page		Description
		Previous Edition	Current Edition	
FEDL9077-01	Jan.30,2012	–	–	First edition
FEDL9077-02	Feb.20,2013	6	6	Min value “1.5 5” of Overcharge non- prevention is corrected to “1.05”.

NOTES

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