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FUJITSU SEMICONDUCTOR
DATA SHEET

DS405-00013-0v01-E

Ultra Low Power Buck Power Management IC for Solar and Vibrations Energy Harvesting

MB39C811

■ DESCRIPTION

The MB39C811 is the high efficient buck DC/DC converter IC which adopts the all-wave bridge rectifier using the low-dissipation and the comparator system. It achieves the energy harvest solution for the energy source of the high output impedance such as the piezoelectric transducer.

It is possible to select from eight preset output voltages and supply up to 100 mA of the output current.

■ FEATURES

- Quiescent current (No load, Output in regulation) : 1.5 µA
- Quiescent current (VIN = 2.5 V UVLO) : 550 nA
- Integrated Low Loss Full-Wave Bridge Rectifier
- VIN input voltage range : 2.6 V to 23 V
- Preset output voltage : 1.5 V, 1.8 V, 2.5 V, 3.3 V, 3.6 V, 4.1 V, 4.5 V, 5.0 V
- Output current : Up to 100 mA
- Protection functions
  - Shunt for input protection : VIN ≥ 21 V, Up to 100 mA Pull-down
  - Over current limit
- I/O Power-Good detection signal output

■ APPLICATIONS

- Light energy harvesting
- Piezoelectric energy harvesting
- Electro-Mechanical energy harvesting
- Wireless HVAC sensor
- Stand-alone nano-power buck regulator

2013.6

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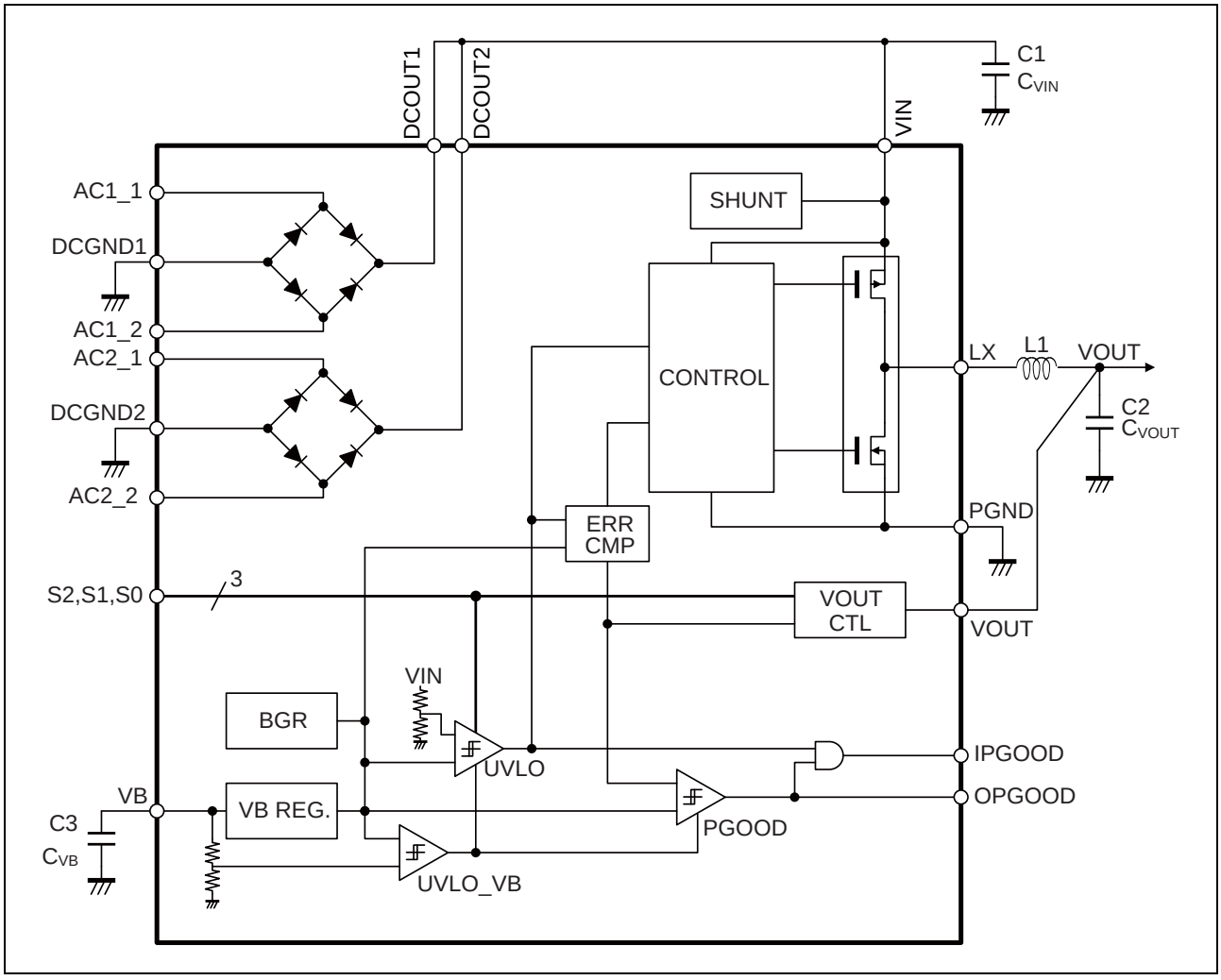
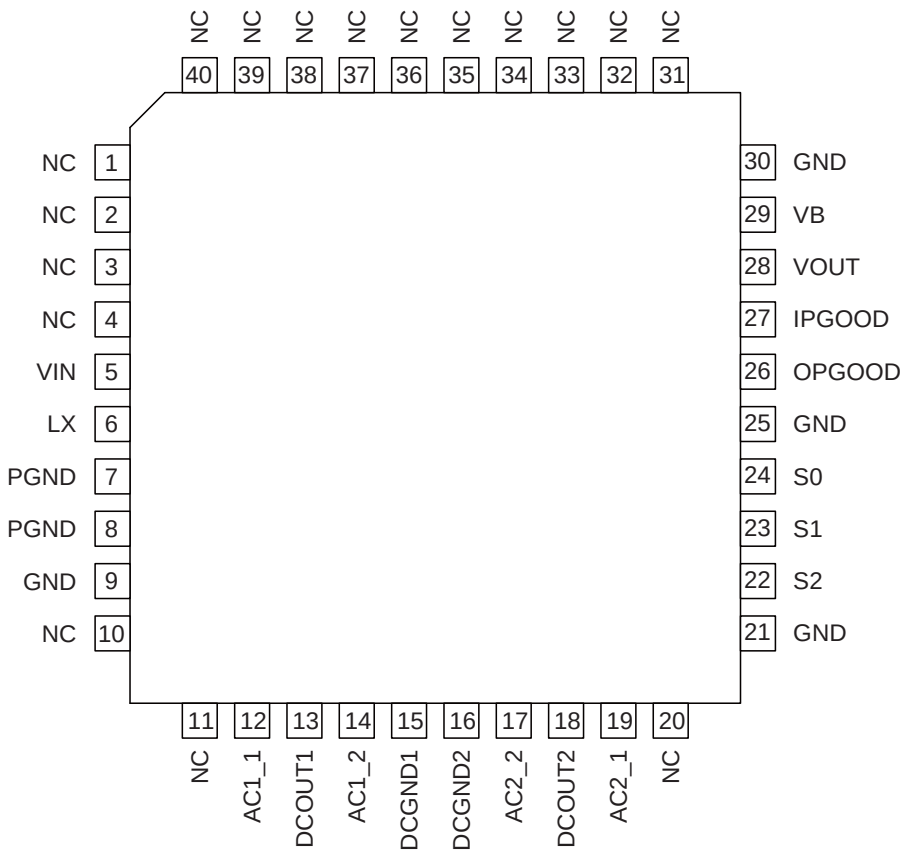
■ BLOCK DIAGRAM



■ PIN ASSIGNMENTS



■ PIN DISCRIPTIONS

Pin No.	Pin Name	I/O	Description
1 to 4	NC	—	Non connection pin
5	VIN	—	DC power supply input pin
6	LX	O	DC/DC output pin
7, 8	PGND	—	PGND pin
9	GND	—	GND pin
10, 11	NC	—	Non connection pin
12	AC1_1	I	Bridge Rectifier1 AC input pin 1
13	DCOUT1	O	Bridge Rectifier1 DC output pin
14	AC1_2	I	Bridge Rectifier1 AC input pin 2
15	DCGND1	—	Bridge Rectifier1 DC output reference pin
16	DCGND2	—	Bridge Rectifier2 DC output reference pin
17	AC2_2	I	Bridge Rectifier2 AC input pin 2
18	DCOUT2	O	Bridge Rectifier2 DC output pin
19	AC2_1	I	Bridge Rectifier2 AC input pin 1
20	NC	—	Non connection pin
21	GND	—	GND pin
22	S2	I	Output voltage select pin 2
23	S1	I	Output voltage select pin 1
24	S0	I	Output voltage select pin 0
25	GND	—	GND pin
26	OPGOOD	O	Output Power-Good output pin
27	IPGOOD	O	Input Power-Good output pin
28	VOUT	I	Output voltage feedback pin
29	VB	O	Internal circuit power supply pin
30	GND	—	GND pin
31 to 40	NC	—	Non connection pin

■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Condition	Rating		Unit
			Min	Max	
VIN pin input voltage	V_{VINMAX}	VIN pin	− 0.3	+ 24	V
VIN pin input slew rate	SR_{MAX}	VIN pin	—	1.5	V/ms
AC pin input voltage	V_{ACMAX}	AC1_1 pin, AC1_2 pin, AC2_1 pin, AC2_2 pin	− 0.3	+ 24	V
LX pin input voltage	V_{LXMAX}	LX pin	− 0.3	+ 24	V
Input voltage	$V_{VINPUTMAX}$	S0 pin, S1 pin, S2 pin	− 0.3	V_{VB} + 0.3 (≤ + 7.0)	V
		VOUT pin	− 0.3	+ 7.0	V
Power dissipation	P_D	Ta ≤ + 25 °C	TBD	TBD	mW
Storage temperature	T_{STG}	—	− 55	+ 125	°C
ESD voltage 1	V_{ESDH}	Human Body Model (100 pF, 1.5 kΩ)	− 2000	+ 2000	V
ESD voltage 2	V_{ESDM}	Machine Model (200 pF, 0 Ω)	− 200	+ 200	V

WARNING: Semiconductor devices may be permanently damaged by application of stress (including, without limitation, voltage, current or temperature) in excess of absolute maximum ratings.
Do not exceed any of these ratings.

■ RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
VIN pin input voltage	V_{VIN}	VIN pin	2.6	—	23	V
VIN pin input slew rate	SR_{VIN}	VIN pin	—	—	1	V/ms
AC pin input voltage	V_{PV}	AC1_1 pin, AC1_2 pin, AC2_1 pin, AC2_2 pin	—	—	23	V
AC pin input current	I_{PV}	AC1_1 pin, AC1_2 pin, AC2_1 pin, AC2_2 pin	—	—	50	mA
Input voltage	V_{SI}	S0 pin, S1 pin, S2 pin	0	—	V_{VB}	V
	V_{FB}	VOUT pin	0	—	5.5	V
Operating ambient temperature	Ta	—	− 40	—	+ 85	°C

WARNING: The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated under these conditions.

Any use of semiconductor devices will be under their recommended operating condition.
Operation under any conditions other than these conditions may adversely affect reliability of device and could result in device failure.

No warranty is made with respect to any use, operating conditions or combinations not represented on this data sheet. If you are considering application under any conditions other than listed herein, please contact sales representatives beforehand.

■ ELECTRICAL CHARACTERISTICS

1. DC Characteristics

(Ta = − 40 °C to + 85 °C, V_{VIN} = 7.0 V, L = 22 µH, C_{VOUT} = 47 µF)

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
Input power supply voltage	V_{VIN}	—	2.6	—	23	V
Input slew rate	SR_{VIN}	—	—	—	1	V/ms
Quiescent current	I_{VIN}	V_{VIN} = 2.5 V (UVLO), Ta = + 25 °C	—	(550)	(775)	nA
		V_{VIN} = 4.5 V (sleep mode), Ta = + 25 °C	—	(1.5)	(2.25)	µA
		V_{VIN} = 18 V (sleep mode), Ta = + 25 °C	—	(1.9)	(2.85)	µA
Preset output voltage	V_{VOUT}	S2 = L, S1 = L, S0 = L	(1.46)	1.5	(1.54)	V
		S2 = L, S1 = L, S0 = H	(1.76)	1.8	(1.84)	V
		S2 = L, S1 = H, S0 = L	(2.44)	2.5	(2.56)	V
		S2 = L, S1 = H, S0 = H	(3.22)	3.3	(3.38)	V
		S2 = H, S1 = L, S0 = L	(3.52)	3.6	(3.68)	V
		S2 = H, S1 = L, S0 = H	(4.00)	4.1	(4.20)	V
		S2 = H, S1 = H, S0 = L	(4.40)	4.5	(4.60)	V
		S2 = H, S1 = H, S0 = H	(4.89)	5.0	(5.11)	V
Over current protection current	I_{PEAK}	—	200	(250)	(350)	mA
Output current	I_{OUT}	—	—	—	100	mA
UVLO release voltage (Input Power-Good detection voltage)	V_{UVLOH}	S2 = L, S1 = L, S0 = L	3.8	4.0	4.2	V
		S2 = L, S1 = L, S0 = H				
		S2 = L, S1 = H, S0 = L				
		S2 = L, S1 = H, S0 = H	5.0	5.2	5.4	V
		S2 = H, S1 = L, S0 = L				
		S2 = H, S1 = L, S0 = H	7.0	7.2	7.4	V
		S2 = H, S1 = H, S0 = L				
		S2 = H, S1 = H, S0 = H				
UVLO detection voltage (Input Power-Good reset voltage)	V_{UVLOL}	S2 = L, S1 = L, S0 = L	2.6	2.8	3.0	V
		S2 = L, S1 = L, S0 = H				
		S2 = L, S1 = H, S0 = L				
		S2 = L, S1 = H, S0 = H	3.8	4.0	4.2	V
		S2 = H, S1 = L, S0 = L				
		S2 = H, S1 = L, S0 = H	5.8	6.0	6.2	V
		S2 = H, S1 = H, S0 = L				
		S2 = H, S1 = H, S0 = H				
VIN pin shunt voltage	V_{SHUNT}	—	19	21	23	V
VIN pin shunt current	I_{SHUNT}	—	100	—	—	mA

(Continued)

(Continued)

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
Output Power-Good detection voltage (Rising)	V_{OPGH}	To preset voltage ratio	90	94	98	%
Output Power-Good reset voltage (Falling)	V_{OPGL}	To preset voltage ratio	(65.5)	70	(74.5)	%
Power supply output voltage for internal circuit	V_{VB}	V_{VIN} = 6 V to 20 V	—	5.0*	—	V

*: This parameter is not be specified. This should be used as a reference to support designing the circuits.

Note: The values in parentheses are provisional values.

2. Built-in bridge rectification circuit

(Ta = + 25 °C)

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
Forward bias voltage	V_F	I_F = 10 µA	(150)	(280)	(450)	mV
Forward direction current	I_F	—	—	—	(50)	mA
Reverse bias leak current	I_R	V_R = 18 V	—	—	20	nA
Break down voltage	V_{BREAK}	I_R = 1 µA	V_{SHUNT}	25	—	V

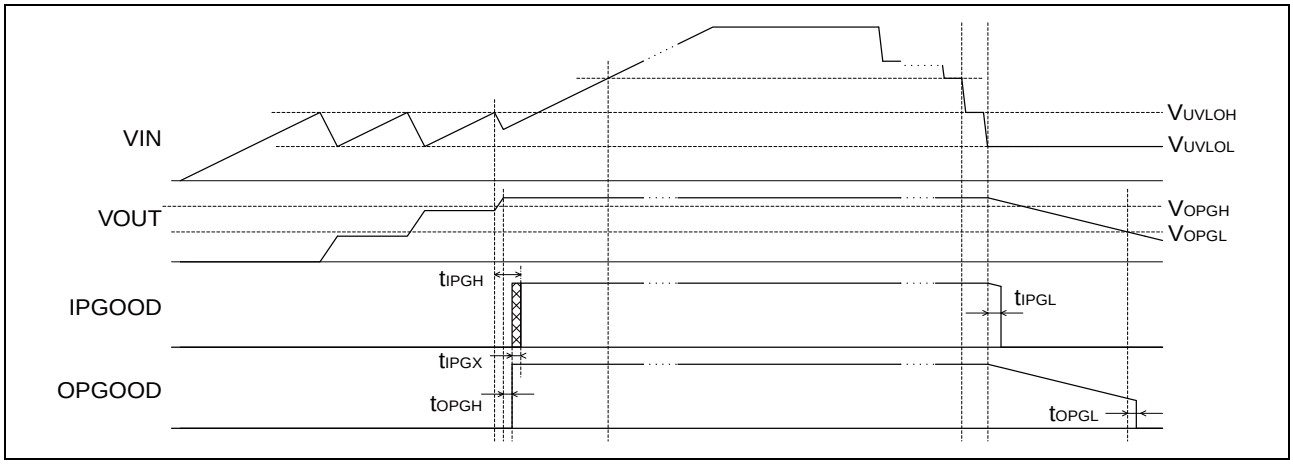
Note: The values in parentheses are provisional values.

3. AC Characteristics

- Input/output Power-Good

(Ta = + 25 °C, V_{VOUT} = 3.3 V)

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
Input Power-Good detection delay time (Rising)	t_{IPGH}	SR_{VIN} = 0.1 V/ms	—	(1)	—	ms
Input Power-Good reset delay time (Falling)	t_{IPGL}	SR_{VIN} = 0.1 V/ms	—	(1)	—	ms
Input Power-Good undefined time	t_{IPGX}	OPGOOD rising	—	(1)	(3)	ms
Output Power-Good detection delay time (Rising)	t_{OPGH}	I_{OUT} = 0 mA, L = 22 µH, C_{VOUT} = 47 µF	—	(1)	—	ms
Output Power-Good reset delay time (Falling)	t_{OPGL}	I_{OUT} = 1mA, C_{VOUT} = 47 µF	—	(1)	—	ms



■ OPERATION SUMMARY

(1) Bridge Rectifier

The A/C voltage which is input to the AC1_1 and AC1_2 pins or the AC2_1 and AC2_2 pins is all-wave rectified at the bridge rectifier of the low-dissipation diode. The bridge rectifier output is output from the DCOUT1 pin and the DCOUT2 pin. By connecting those outputs to the VIN pin, the electric charge is accumulated to the capacitor and it is used as the energy condenser of the buck converter.

(2) Power supply for internal circuit

When the VIN pin voltage is 3.5 V or lower, the power supply is supplied from the VIN pin to the internal circuit directly. If the VIN pin is over 3.5 V, the internal regulator is activated and the power supply is supplied from the internal regulator to the internal circuit. Therefore, the stable output voltage is maintained in the wide input voltage range 2.6 V to 23 V.

(3) DC/DC Start-up/Shut-down

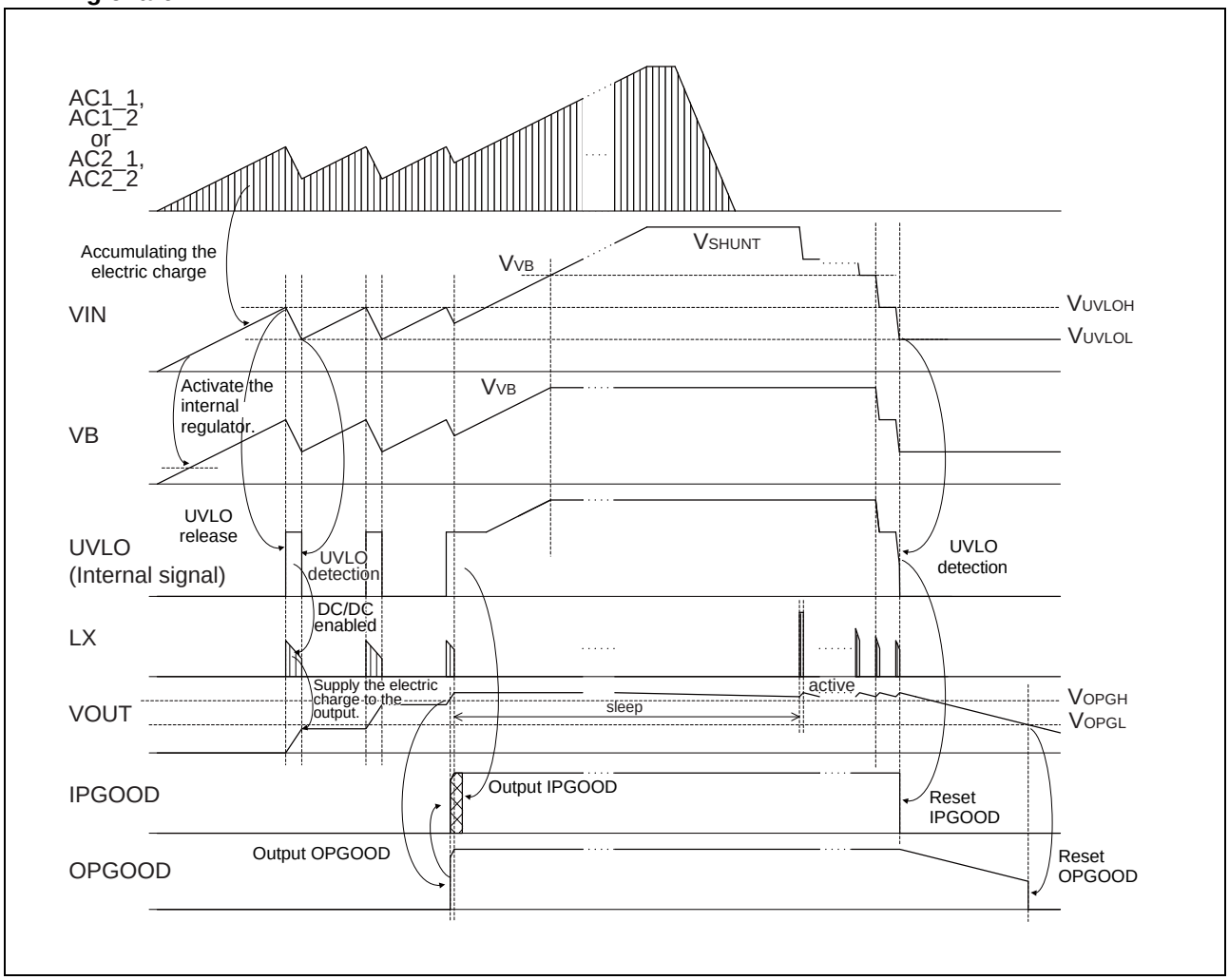
When the VIN pin voltage is over the release voltage V_{UVLOH} for the under voltage lockout protection circuit (UVLO), the converter circuit is enabled and the electric charge is supplied from the input capacitor to the output capacitor. When the VIN pin voltage is below the UVLO detection voltage V_{UVLOL}, the converter is disabled. The 1.2 V hysteresis between the release voltage and the detection voltage for UVLO prevents the converter from noise or frequent ON/OFF which is caused by the VIN pin voltage-drop during start-up.

(4) Sleep/Auto active control

When the feedback voltage V_{FB} for the converter reaches the determinate voltage, the sleep state to stop the switching operation starts and that can reduce the consumption power from the internal circuit. When the VOUT voltage is below the threshold value, the VOUT voltage is maintained to the rated value by making the converter active again.

■ START UP/SHUT DOWN SEQUENCE

<Timing chart>



■ FUNCTION

(1) Output voltage setting & Under Voltage Lockout Protection (UVLO) function

It is possible to select the output voltage from eight kinds of presets using the S2, S1 and S0 pins.

Also, the under voltage lockout protection circuit is provided to prevent IC's malfunction by the transient state or the instant drop during the VIN pin voltage activation, system destroy and deterioration, and it is set as follows according to the preset voltage. When the VIN pin exceeds the release voltage for the UVLO circuit, the system is recovered.

S2	S1	S0	VOUT [V]	Under Voltage Lockout Protection (UVLO)	
				Detection voltage (Falling) V_{UVLOL} [V]	Release voltage (Rising) V_{UVLOH} [V]
L	L	L	1.5	2.8	4.0
L	L	H	1.8	2.8	4.0
L	H	L	2.5	2.8	4.0
L	H	H	3.3	4.0	5.2
H	L	L	3.6	4.0	5.2
H	L	H	4.1	6.0	7.2
H	H	L	4.5	6.0	7.2
H	H	H	5.0	6.0	7.2

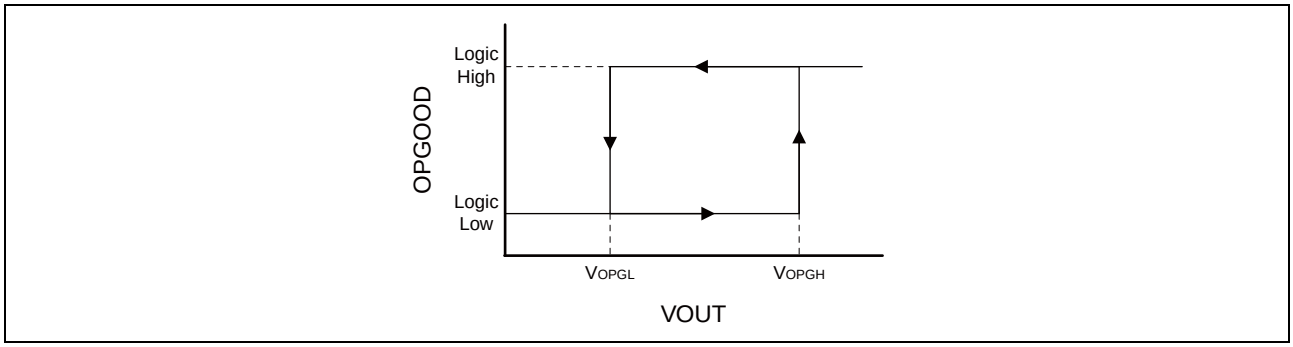
(2) Input/output Power-Good signal output

When the VIN pin input voltage is equal to the release voltage V_{UVLOH} for UVLO or more, the output for the IPGOOD pin is set to the “H” level as the input Power-Good. When the VIN pin input voltage is equal to the detection voltage V_{UVLOL} for UVLO or less, the output for the IPGOOD pin is reset to the “L” level. The IPGOOD output is enabled only when the following output Power-Good signal output OPGOOD is “H” level.

The output Power-Good signal OPGOOD is set to the “H” level when the feedback voltage V_{FB} for the VOUT pin is equal to the detection voltage V_{OPGH} or more. When the feedback voltage V_{FB} is equal to the reset voltage V_{OPGL} or less, the output for the OPGOOD pin is reset to the “L” level.

OPGOOD	UVLO	IPGOOD
L	Don't care	L
H	L	L
H	H	H

V_{FB}	OPGOOD
≤ V_{OPGL}	L
≥ V_{OPGH}	H



(3) Input Over voltage Protection

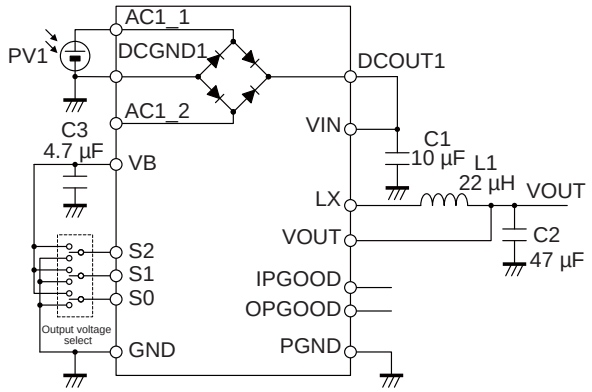
If the voltage exceeding V_{SHUNT} (Typ 21 V) is input to the VIN pin, the input level is clamped enabling the over voltage protection circuit. The flowing current is I_{SHUNT} (Min 100 mA) during clamp.

(4) Over Current Protection

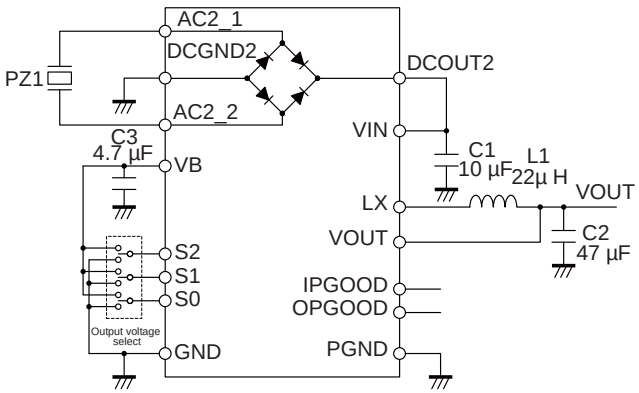
If the output current for the LX pin reaches the over current detection level I_{PEAK}, the circuit is protected by controlling the peak value for the inductor current setting the main side FET to the OFF state.

■ TYPICAL APPLICATIONS CIRCUIT

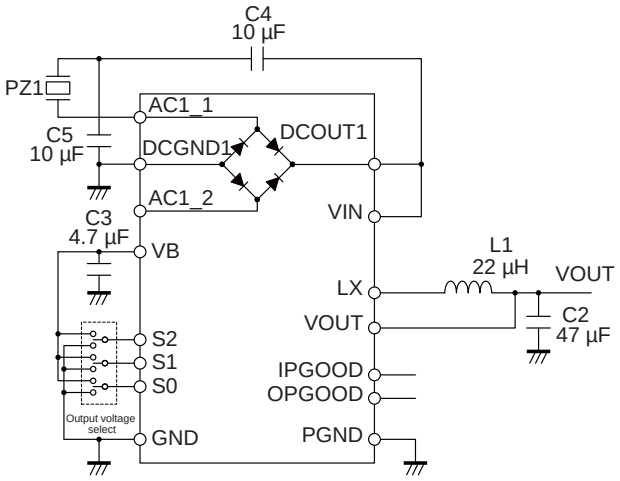
- Circuit for light harvest power generation



- Circuit for oscillation harvest power generation



- AC input voltage doubler rectification circuit



• Parts list

Specification	Value	Description
C1	10 µF*	Capacitor
C2	47 µF*	Capacitor
C3	4.7 µF	Capacitor
C4	10 µF*	Capacitor
C5	10 µF*	Capacitor
L1	10 µH to 22 µH	Inductor

* : Adjust the values according to the source supply ability and the load power.

■ USAGE PRECAUTION

1. Do not configure the IC over the maximum ratings

If the IC is used over the maximum ratings, the LSI may be permanently damaged.
It is preferable for the device to be normally operated within the recommended usage conditions. Usage outside of these conditions can have a bad effect on the reliability of the LSI.

2. Use the devices within recommended operating conditions

The recommended operating conditions are the recommended values that guarantee the normal operations of LSI.
The electrical ratings are guaranteed when the device is used within the recommended operating conditions and under the conditions stated for each item.

3. Printed circuit board ground lines should be set up with consideration for common impedance

4. Take appropriate measures against static electricity

- Containers for semiconductor materials should have anti-static protection or be made of conductive material.
- After mounting, printed circuit boards should be stored and shipped in conductive bags or containers.
- Work platforms, tools, and instruments should be properly grounded.
- Working personnel should be grounded with resistance of 250 kΩ to 1 MΩ in series between body and ground.

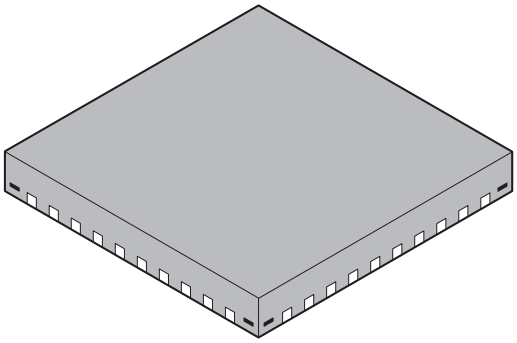
5. Do not apply negative voltages

The use of negative voltages below –0.3 V may cause the parasitic transistor to be activated on LSI lines, which can cause malfunctions.

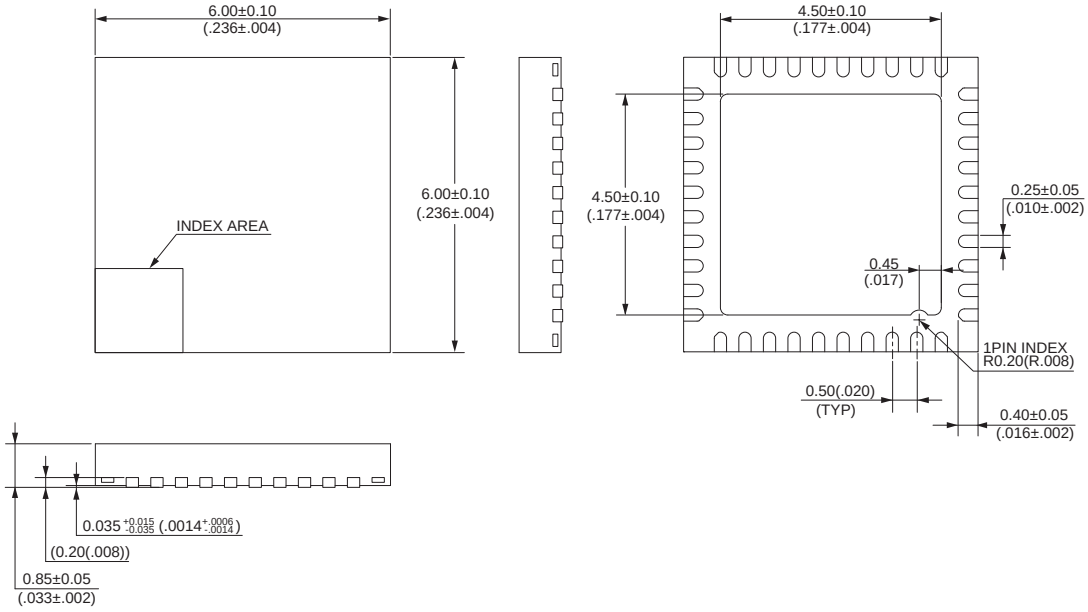
■ ORDERING INFORMATION

Part number	Package	Remarks
MB39C811QN	40-pin plastic QFN (LCC-40P-M63)	

■ PACKAGE DIMENSIONS

40-pin plastic QFN		
 (LCC-40P-M63)	Lead pitch	0.50 mm
	Package width × package length	6.00 mm × 6.00 mm
	Sealing method	Plastic mold
	Mounting height	0.90 mm MAX
	Weight	0.10 g

40-pin plastic QFN
(LCC-40P-M63)



Dimensions in mm (inches).
Note: The values in parentheses are reference values.

MEMO

MEMO

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