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Spec No: 002-04361

Spec Title: AN204361 - HYBRID APPLICATION USING ENERGY HARVESTING PMIC

Replaced by: None

Hybrid Application using Energy Harvesting PMIC

Associated Part Family: MB39C811

This application note introduces the way how to setup hybrid application on Energy Harvesting Power Management Integrated Circuits (PMICs) and some samples to explain briefly which setups can generate hybrid application.

1 Introduction

This application note introduces the way how to setup hybrid application on Energy Harvesting Power Management Integrated Circuits (PMICs).

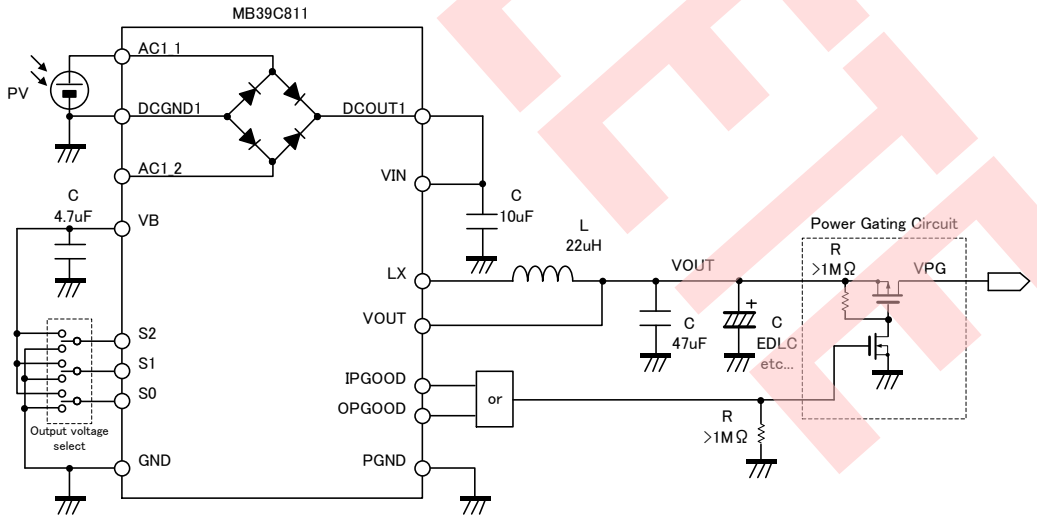
This application note shows some samples to explain briefly which setups can generate hybrid application. Besides, refer to Energy Harvesting PMIC datasheet accordingly.

2 Example of Power Gating Circuit

The Energy Harvesting Power Management ICs can generate hybrid application which can connect both harvester and other power source at same time, using power gating circuit.

Figure 1circuit is example of power gating for MB39C811. IPGOOD or OPGOOD of MB39C811 is connected to the gate of Nch FET to drive Pch FET gate. The gate of Pch FET is pulled up to VOUT. The power gating will be enabled when PGOOD is high. The power gating will be disabled when PGOOD is low. The recommended values of registers for VOUT/PGOOD are 1MΩ or more.

Figure 1. Example of Power Gating Circuit



There are two power information signals which are IPGOOD and OPGOOD to drive the power gating circuit. The following is information for it. Regarding to detail information, refer to the datasheet of MB39C811.

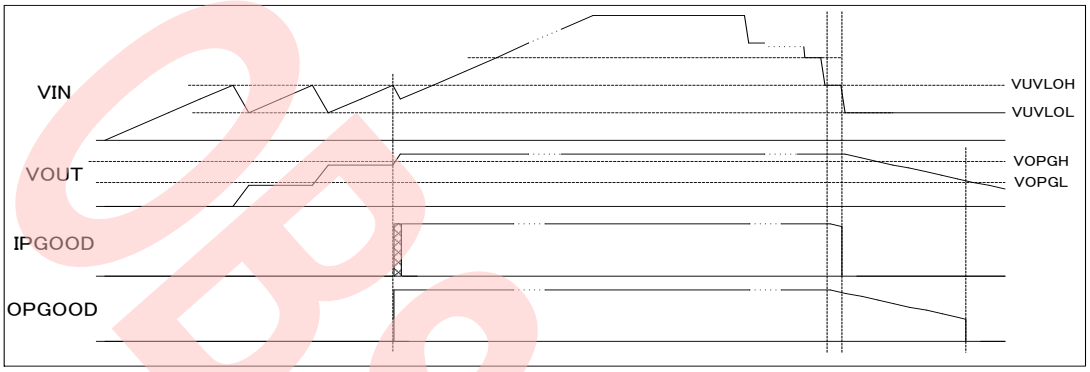
IPGOOD

When the VIN pin input voltage is equal to the release voltage (VUVLOH) 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 (VUVLOL) 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.

OPGOOD

The output Power-Good signal OPGOOD is set to the “H” level when the feedback voltage VFB for the VOUT pin is equal to the detection voltage (VOPGH) or more. When the feedback voltage VFB is equal to the reset voltage (VOPGL) or less, the output for the OPGOOD pin is reset to the “L” level.

Figure 2. Operating information of PGOOD



MB39C811 Recommended Operating Conditions

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
UVLO release voltage (Input Power-Good detection voltage)	VUVLOH	VOUT = 1.5V	3.8	4.0	4.2	V
		VOUT = 1.8V				V
		VOUT = 2.5V				V
		VOUT = 3.3V	4.94	5.2	5.46	V
		VOUT = 3.6V				V
		VOUT = 4.1V	6.84	7.2	7.56	V
		VOUT = 4.5V				V
		VOUT = 5.0V				V
UVLO detection voltage (Input Power-Good reset voltage)	VUVLOL	VOUT = 1.5V	2.6	2.8	3.0	V
		VOUT = 1.8V				V
		VOUT = 2.5V				V
		VOUT = 3.3V	3.8	4.0	4.2	V
		VOUT = 3.6V				V
		VOUT = 4.1V	5.7	6.0	6.3	V
		VOUT = 4.5V				V
		VOUT = 5.0V				V
Output Power-Good detection voltage (Rising)	VOPGH	To preset voltage ratio	90	94	98	%
Output Power-Good reset voltage (Falling)	VOPGL	To preset voltage ratio	65.5	70	74.5	%

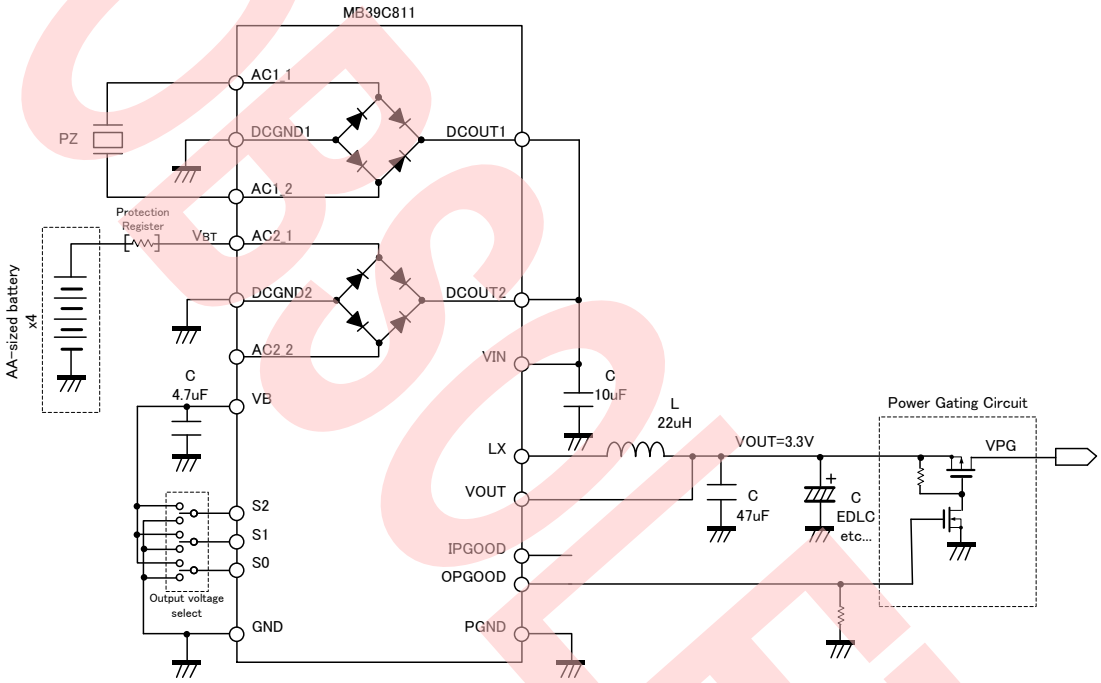
Refer to the datasheet of MB39C811 (DS405-00013) about detail and latest information.

3 Example of Hybrid Application

3.1 Example Circuit by Series Connection Primary-Battery

It is easily possible to generate hybrid application using the rectifier diodes in MB39C811. The Figure 3 is example circuit using vibration energy (Piezoelectric), and the four AA size cell alkali batteries “1.5V × 4 series = 6V”. The output voltage of MB39C811 is 3.3V. It can operate just harvester energy by using power gating circuit when battery will be discharged.

Figure 3. Example Circuit by Series Connection Primary-Battery



The number of series battery is depended on UVLO release voltage (VUVLOH). The following table is VUVLOH values. Connect primary-battery more than UVLO release voltage of MB39C811.

Ex. For setting Figure 3 (four AA size cell alkali batteries, VOUT=3.3V)

V_{BT} = 6V > VUVLOH = Max: 5.4V

Please be careful that the MB39C811 maximum current of AC input pins is 50mA.

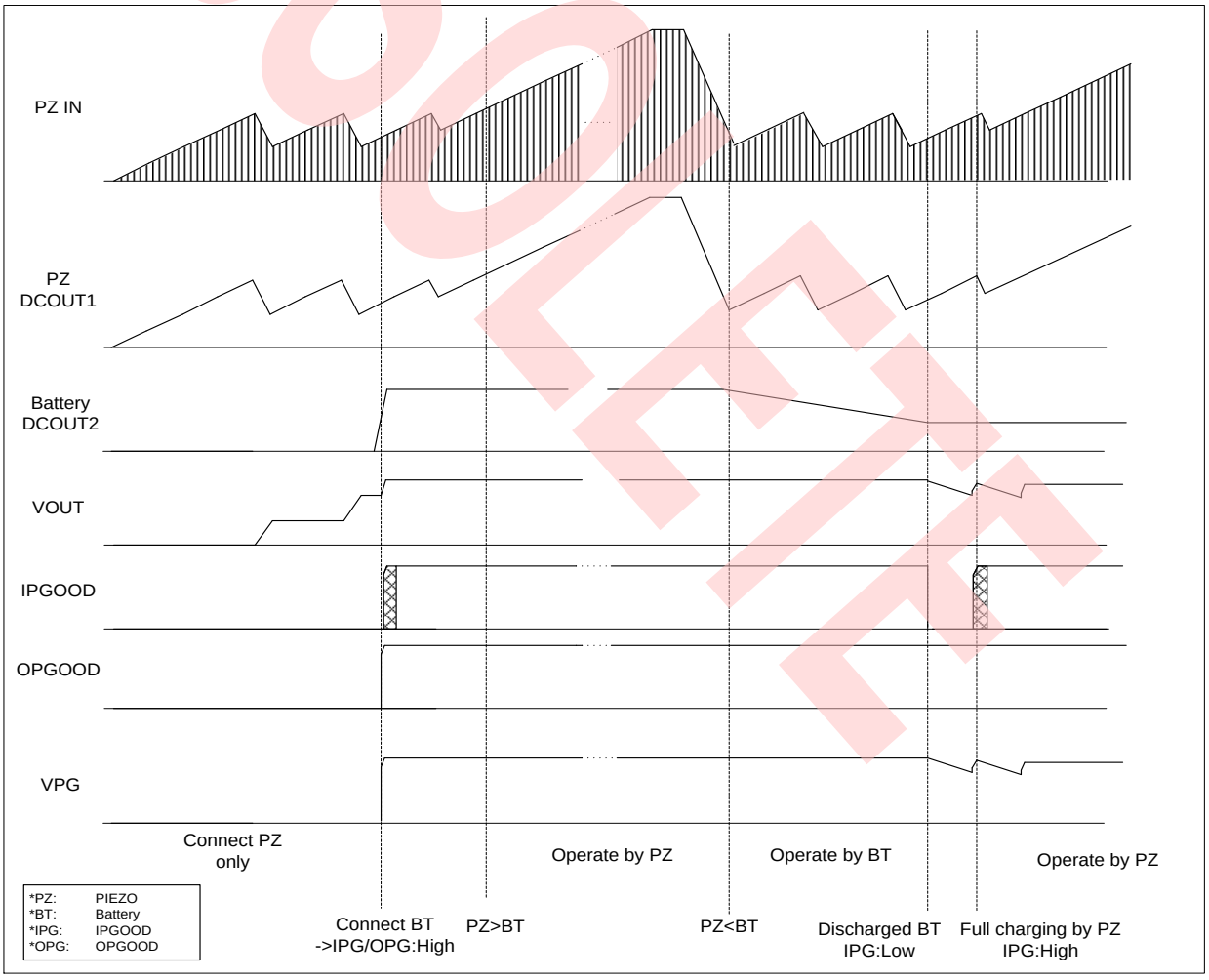
Therefore, recommend connecting the current limit register to between coin battery and rectifier diodes when the system needs input current for 50mA or more. Recommend resister value is 120Ω or more by Ohm’s law.

MB39C811 Recommended Operating Conditions

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
UVLO release voltage (Input Power-Good detection voltage)	VUVLOH	VOUT = 1.5V	3.8	4.0	4.2	V
		VOUT = 1.8V				V
		VOUT = 2.5V				V
		VOUT = 3.3V	5.0	5.2	5.4	V
		VOUT = 3.6V				V
		VOUT = 4.1V	7.0	7.2	7.4	V
		VOUT = 4.5V				V
		VOUT = 5.0V				V

Refer to the datasheet of MB39C811 (DS405-00013) about detail and latest information.

Figure 4. Example Waveform by Series Connection Primary-Battery

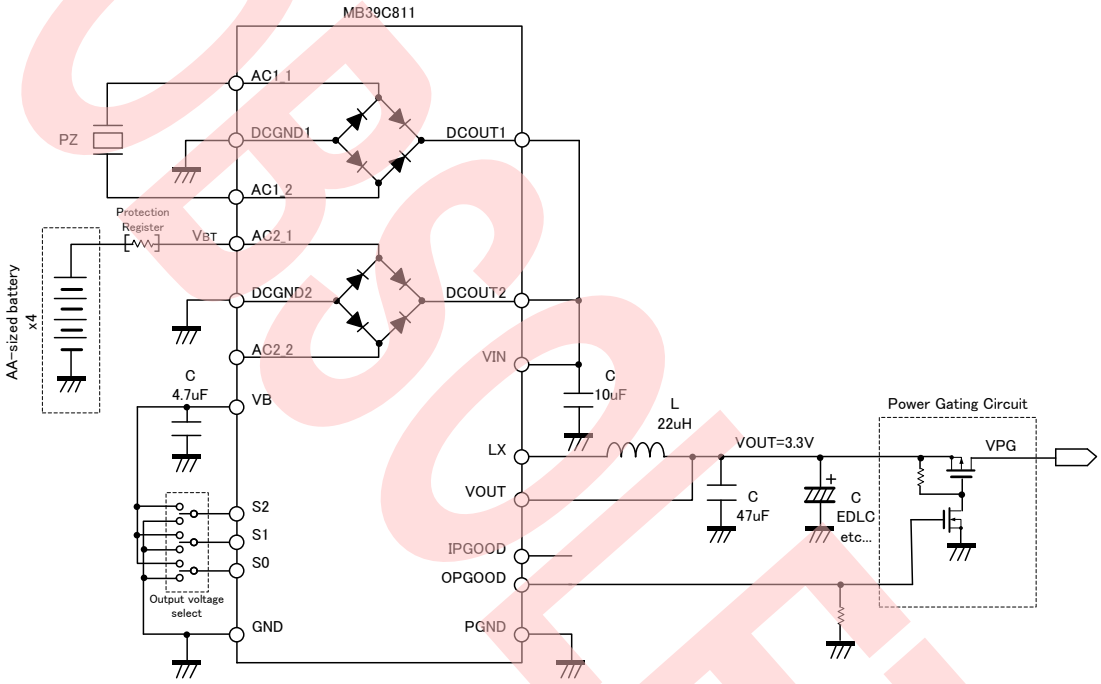


3.2 Example Circuit by 3V Coin Primary-Battery

The 3V coin battery is less than UVLO release voltage “VUVLOH” of MB39C811 when connecting 3V coin primary-battery to MB39C811 directly. Therefore it has to connect DCDC feedback output and coin battery, to the rectifier diodes in MB39C811 to generate hybrid application.

The Figure 5 circuit is connected DCDC output through power gating circuit to the rectifier diodes in MB39C811. It is possible to generate hybrid circuit by using feedback DCDC power and coin battery through the rectifier diodes. The VHB output voltage is able to be stabled to add capacitor on VHB line.

Figure 5. Example Circuit by Series Connection Primary-Battery



The number of series battery is depended on UVLO release voltage (VUVLOH). The following table is VUVLOH values. Connect primary-battery more than UVLO release voltage of MB39C811.

Ex. For setting Figure 3 (four AA size cell alkali batteries, VOUT=3.3V)

V_{BT} = 6V > VUVLOH = Max:5.4V

Please be careful that the MB39C811 maximum current of AC input pins is 50mA.

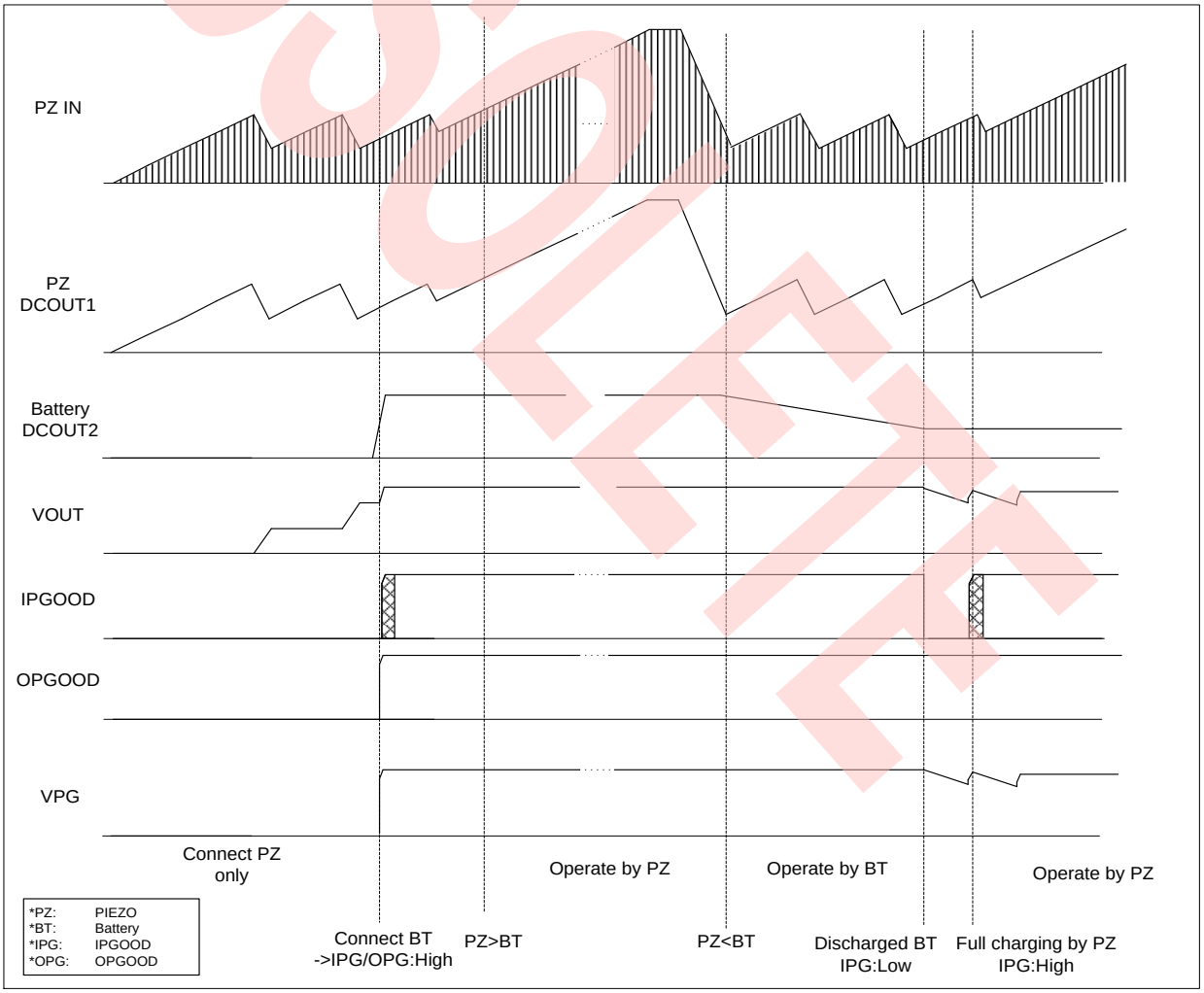
Therefore, recommend connecting the current limit register to between coin battery and rectifier diodes when the system needs input current for 50mA or more. Recommend resister value is 120Ω or more by Ohm’s law.

MB39C811 Recommended Operating Conditions

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
UVLO release voltage (Input Power-Good detection voltage)	VUVLOH	VOUT = 1.5V	3.8	4.0	4.2	V
		VOUT = 1.8V				V
		VOUT = 2.5V				V
		VOUT = 3.3V	5.0	5.2	5.4	V
		VOUT = 3.6V				V
		VOUT = 4.1V	7.0	7.2	7.4	V
		VOUT = 4.5V				V
		VOUT = 5.0V				V

Refer to the datasheet of MB39C811 (DS405-00013) about detail and latest information.

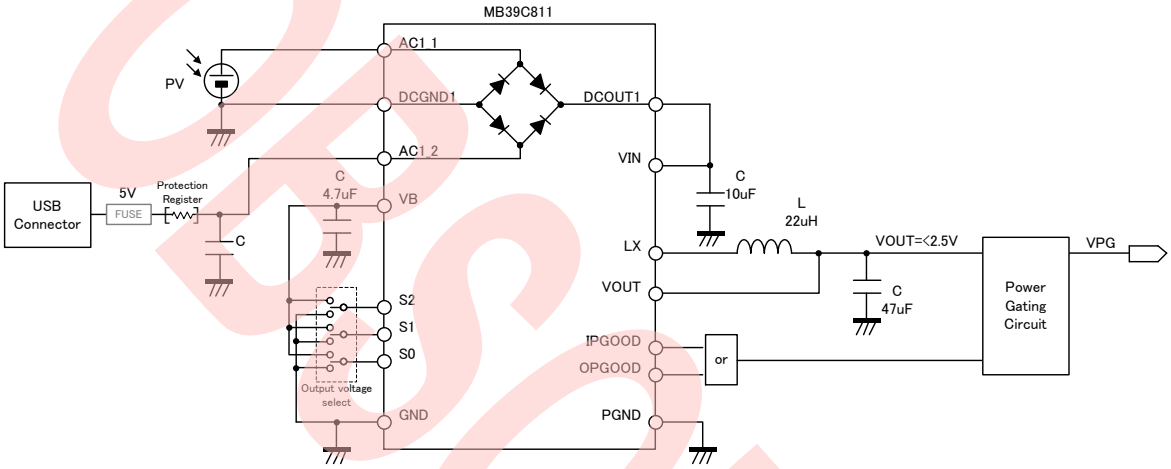
Figure 6. Example Waveform by Series Connection Primary-Battery



3.3 Example Circuit by USB Bus Power

It is possible to generate hybrid application using USB bus power when the output setting of MB39C811 is set to 2.5V or less. It is the most suitable for USB application which has been used debug, PC setting and so on. The Figure 3-5 is the example circuit by using solar cell and USB bus power. When needs the power gating circuit, add it as shown in “2.Example of Power Gating Circuit”.

Figure 7. Example Circuit by USB Bus Power



MB39C811 Recommended Operating Conditions

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
UVLO release voltage (Input Power-Good detection voltage)	VUVLOH	VOUT = 1.5V	3.8	4.0	4.2	V
		VOUT = 1.8V				V
		VOUT = 2.5V				V

Refer to the datasheet of MB39C811 (DS405-00013) about detail and latest information.

4 Document History

Document Title: AN204361 - Hybrid Application using Energy Harvesting PMIC

Document Number: 002-04361

Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	-	TAOA	10/24/2014	Initial Release
*A	5037894	TAOA	12/07/2015	Migrated Spansion Application Note from AN405-00002-1v0-E to Cypress format
*B	5797274	AESATMP8	07/04/2017	Updated logo and Copyright.
*C	6399420	YOST	12/03/2018	Obsoleted.

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