

Please note that Cypress is an Infineon Technologies Company.

The document following this cover page is marked as “Cypress” document as this is the company that originally developed the product. Please note that Infineon will continue to offer the product to new and existing customers as part of the Infineon product portfolio.

Continuity of document content

The fact that Infineon offers the following product as part of the Infineon product portfolio does not lead to any changes to this document. Future revisions will occur when appropriate, and any changes will be set out on the document history page.

Continuity of ordering part numbers

Infineon continues to support existing part numbers. Please continue to use the ordering part numbers listed in the datasheet for ordering.



THIS SPEC IS OBSOLETE

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).

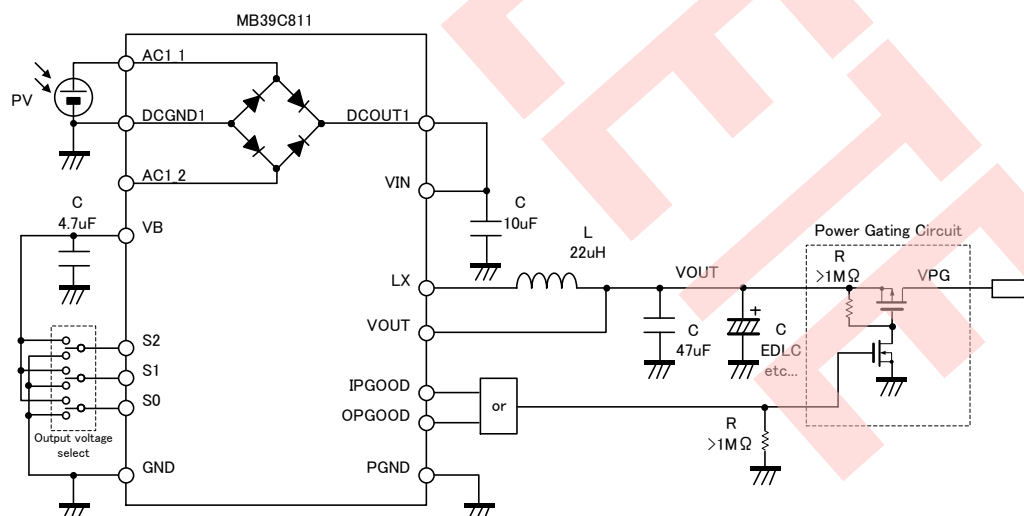
This application note shows some samples to explain briefly which setups can generate hybrid application. Besides, refer to Energy Harvesting PMIC datasheet accordingly.

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 1 circuit 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.

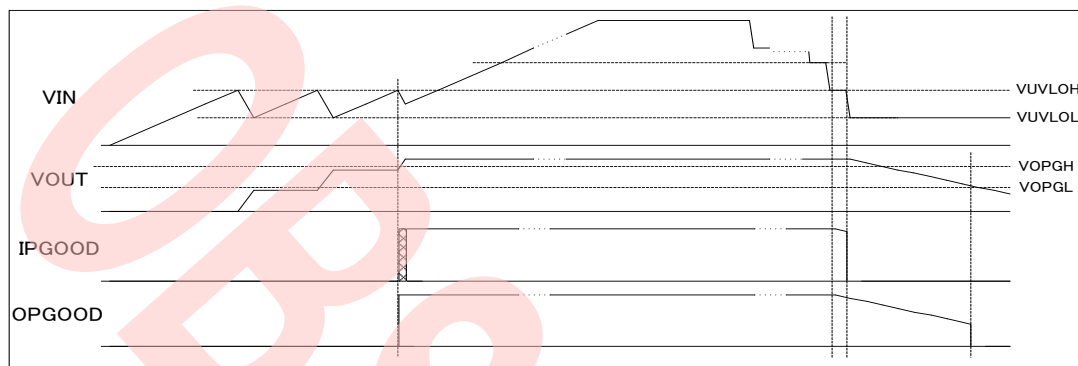
IPGOOD

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	%

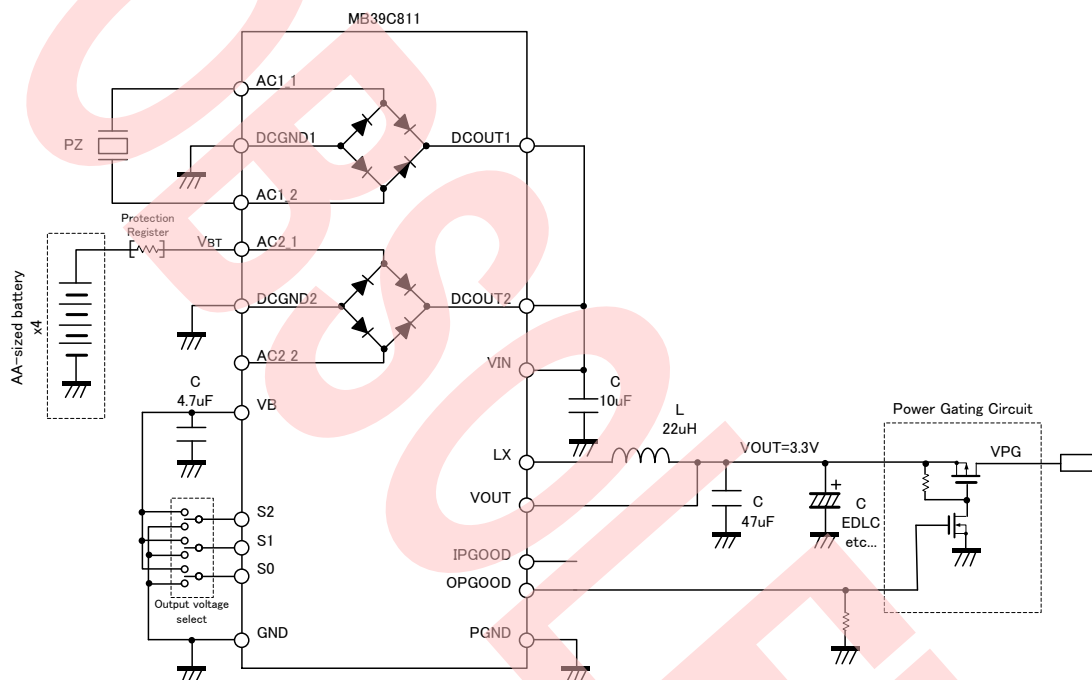
Refer to the datasheet of MB39C811 (DS405-00013) about detail and latest information.

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)

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

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

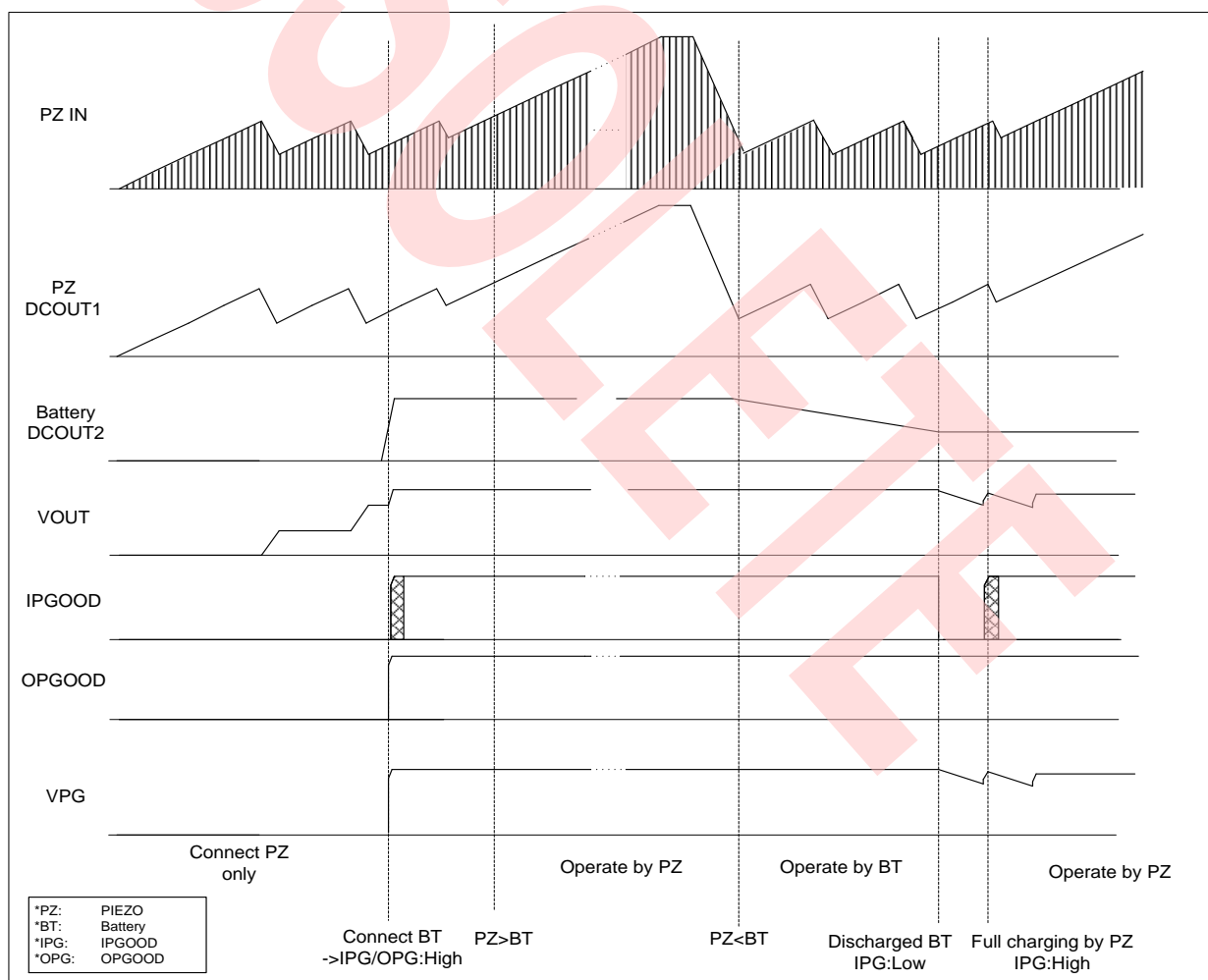
Therefore, recommend connecting the current limit register to between coin battery and rectifier diodes when the system needs input current for 50mA or more. Recommend resister value is 120Ω or more by Ohm's law.

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

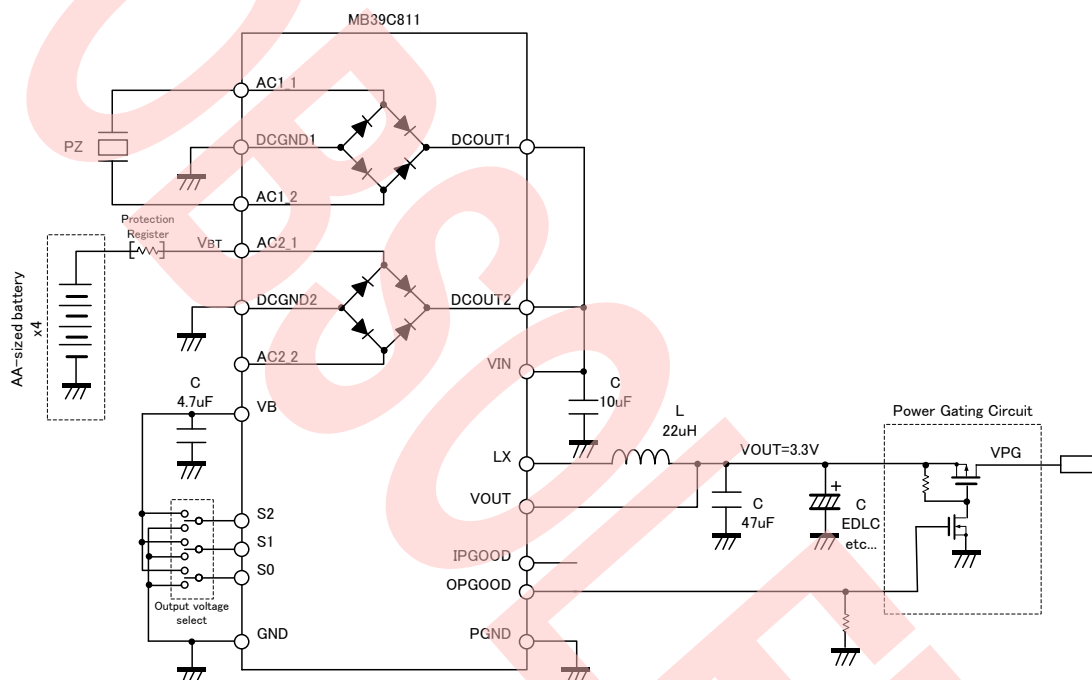


3.2 Example Circuit by 3V Coin Primary-Battery

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)

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

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

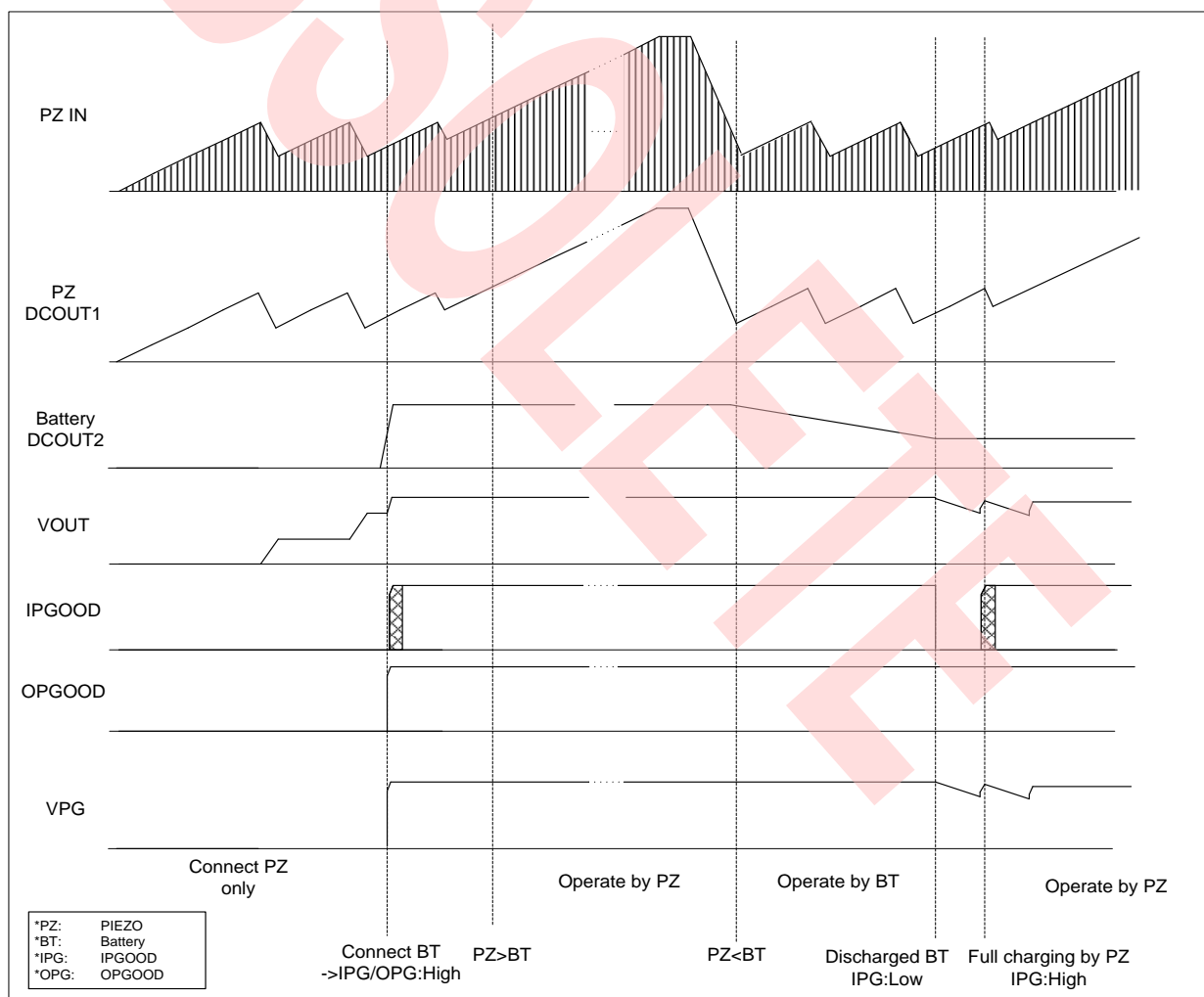
Therefore, recommend connecting the current limit register to between coin battery and rectifier diodes when the system needs input current for 50mA or more. Recommend resister value is 120Ω or more by Ohm's law.

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				V
		VOUT = 4.5V	7.0	7.2	7.4	V
		VOUT = 5.0V				V

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

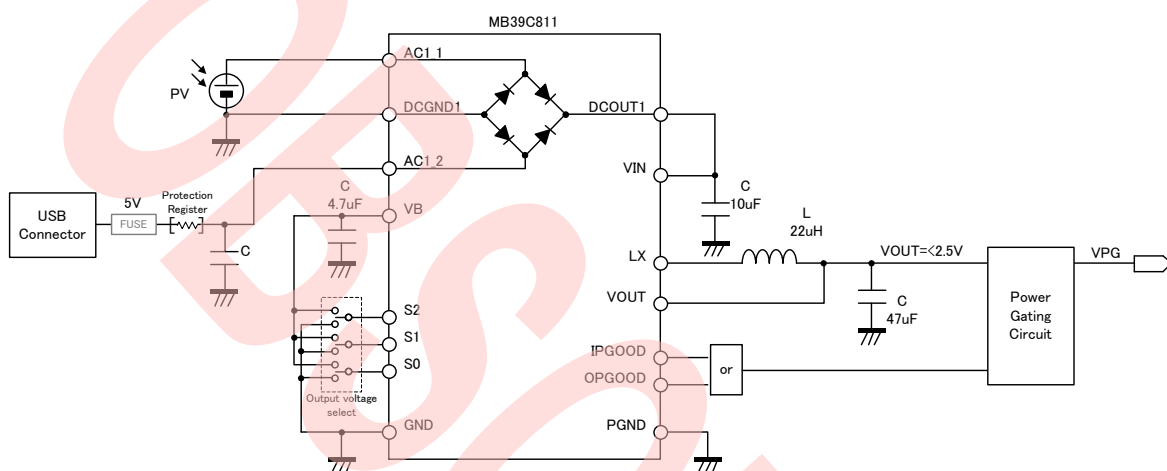
Figure 6. Example Waveform by Series Connection Primary-Battery



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.

Worldwide Sales and Design Support

Cypress maintains a worldwide network of offices, solution centers, manufacturer's representatives, and distributors. To find the office closest to you, visit us at [Cypress Locations](#).

Products

Arm® Cortex® Microcontrollers	cypress.com/arm
Automotive	cypress.com/automotive
Clocks & Buffers	cypress.com/clocks
Interface	cypress.com/interface
Internet of Things	cypress.com/iot
Memory	cypress.com/memory
Microcontrollers	cypress.com/mcu
PSoC	cypress.com/psoc
Power Management ICs	cypress.com/pmic
Touch Sensing	cypress.com/touch
USB Controllers	cypress.com/usb
Wireless Connectivity	cypress.com/wireless

PSoC® Solutions

[PSoC 1](#) | [PSoC 3](#) | [PSoC 4](#) | [PSoC 5LP](#) | [PSoC 6 MCU](#)

Cypress Developer Community

[Community](#) | [Projects](#) | [Videos](#) | [Blogs](#) | [Training](#) | [Components](#)

Technical Support

cypress.com/support

All other trademarks or registered trademarks referenced herein are the property of their respective owners.



© Cypress Semiconductor Corporation, 2014-2018. This document is the property of Cypress Semiconductor Corporation and its subsidiaries, including Spansion LLC ("Cypress"). This document, including any software or firmware included or referenced in this document ("Software"), is owned by Cypress under the intellectual property laws and treaties of the United States and other countries worldwide. Cypress reserves all rights under such laws and treaties and does not, except as specifically stated in this paragraph, grant any license under its patents, copyrights, trademarks, or other intellectual property rights. If the Software is not accompanied by a license agreement and you do not otherwise have a written agreement with Cypress governing the use of the Software, then Cypress hereby grants you a personal, non-exclusive, nontransferable license (without the right to sublicense) (1) under its copyright rights in the Software (a) for Software provided in source code form, to modify and reproduce the Software solely for use with Cypress hardware products, only internally within your organization, and (b) to distribute the Software in binary code form externally to end users (either directly or indirectly through resellers and distributors), solely for use on Cypress hardware product units, and (2) under those claims of Cypress's patents that are infringed by the Software (as provided by Cypress, unmodified) to make, use, distribute, and import the Software solely for use with Cypress hardware products. Any other use, reproduction, modification, translation, or compilation of the Software is prohibited.

TO THE EXTENT PERMITTED BY APPLICABLE LAW, CYPRESS MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARD TO THIS DOCUMENT OR ANY SOFTWARE OR ACCOMPANYING HARDWARE, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. No computing device can be absolutely secure. Therefore, despite security measures implemented in Cypress hardware or software products, Cypress does not assume any liability arising out of any security breach, such as unauthorized access to or use of a Cypress product. In addition, the products described in these materials may contain design defects or errors known as errata which may cause the product to deviate from published specifications. To the extent permitted by applicable law, Cypress reserves the right to make changes to this document without further notice. Cypress does not assume any liability arising out of the application or use of any product or circuit described in this document. Any information provided in this document, including any sample design information or programming code, is provided only for reference purposes. It is the responsibility of the user of this document to properly design, program, and test the functionality and safety of any application made of this information and any resulting product. Cypress products are not designed, intended, or authorized for use as critical components in systems designed or intended for the operation of weapons, weapons systems, nuclear installations, life-support devices or systems, other medical devices or systems (including resuscitation equipment and surgical implants), pollution control or hazardous substances management, or other uses where the failure of the device or system could cause personal injury, death, or property damage ("Unintended Uses"). A critical component is any component of a device or system whose failure to perform can be reasonably expected to cause the failure of the device or system, or to affect its safety or effectiveness. Cypress is not liable, in whole or in part, and you shall and hereby do release Cypress from any claim, damage, or other liability arising from or related to all Unintended Uses of Cypress products. You shall indemnify and hold Cypress harmless from and against all claims, costs, damages, and other liabilities, including claims for personal injury or death, arising from or related to any Unintended Uses of Cypress products.

Cypress, the Cypress logo, Spansion, the Spansion logo, and combinations thereof, WICED, PSoC, CapSense, EZ-USB, F-RAM, and Traveo are trademarks or registered trademarks of Cypress in the United States and other countries. For a more complete list of Cypress trademarks, visit cypress.com. Other names and brands may be claimed as property of their respective owners.