Data Sheet

Rev. 1.00 / April 2012

ZSPM4121

Under-Voltage Load Switch for Smart Battery Management

ZSPM4121

Under-Voltage Load Switch for Smart Battery Management

Brief Description

The ZSPM4121 battery management load switch can be used to protect a battery from excessive discharge. It actively switches the battery power source off if it drops to a set threshold (Off Mode). When the input battery voltage is above the threshold, the load switch is on (On Mode). The ZSPM4121 threshold voltage (V_{THRESH}) is programmed at manufacturing to a set point in the range of 1.2V to 4.2V with 100mV steps between options.

When the input battery voltage has been switched off by the ZSPM4121, the quiescent current draw on the battery is in the order of 100pA (typical). The quiescent current in the on state is as low as 70nA.

The ZSPM4121 consists of an internally generated threshold voltage, a comparator with hysteresis, slew rate control for the load switch, a P-channel load switch, and an open-drain indicator pin. The 500mV hysteresis between the Off Mode and the On Mode prevents intermittent operation. The ZSPM4121 also provides over-current protection.

Benefits

- Best-in-class ultra-low quiescent current in Off Mode: 100pA (typical)
- Ultra-low quiescent current in On Mode: 70nA (typical)
- Accurate on/off voltage threshold
- Low Rds(on): 175mΩ (typical) @ 5V

Features

- Power source is actively switched off when VCC drops below a set threshold (programmed at manufacturing)
- Wide input voltage range: 1.2V to 5.5V
- Threshold voltage options of 1.2V to 4.2V in 100mV steps (factory programmed)
- Supervisory over-current limit shutdown
- Low drop out disconnect from VCC to loads
- Controlled turn-on slew rate
- 500mV Off Mode to On Mode hysteresis
- Over current shutdown (3A)

Related ZMDI Smart Power Products

- ZSPM4141 Ultra-Low-Power Linear Regulator

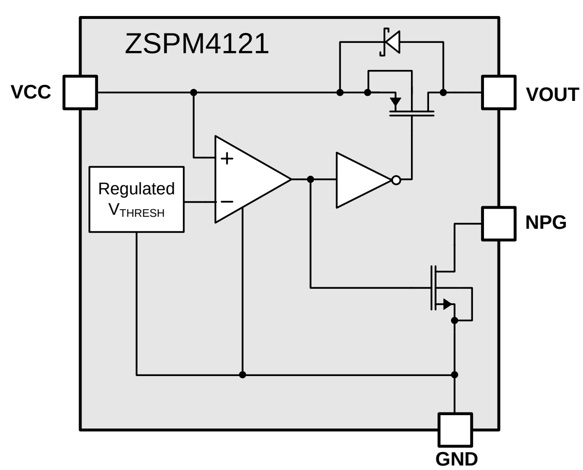
Available Support

- Evaluation Kit
- Support Documentation

Physical Characteristics

- Package: 8-pin DFN (2mm x 2mm)

ZSPM4121 Block Diagram



Note: At manufacturing, V_{THRESH} is programmed to a customer-selected threshold voltage in the range of 1.2V to 4.2V with 100mV steps between options.

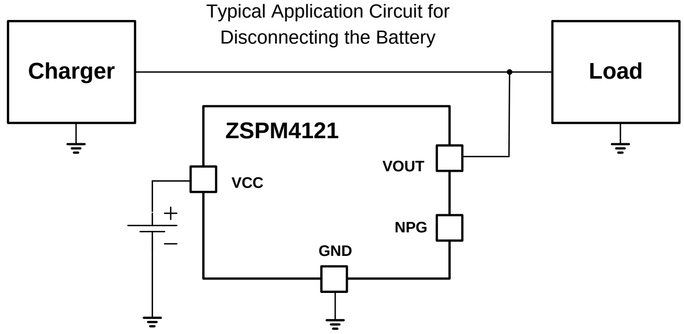
ZSPM4121

Under-Voltage Load Switch for Smart Battery Management

The Analog Mixed Signal Company

Typical Application Circuits:

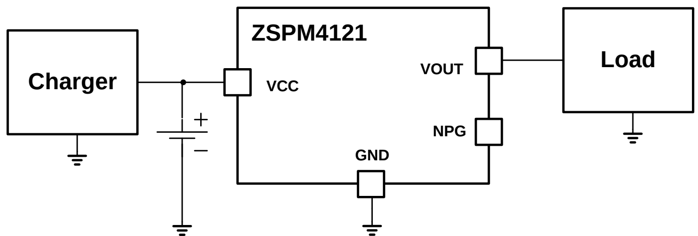
Typical Application Circuit for Disconnecting the Battery



Typical Applications

- Portable Batteries
- Industrial
- Medical
- Smart cards
- RFID

Typical Application Circuit for Disconnecting the Load



Ordering Information

Ordering Code*	Description	Package
ZSPM4121AI1*W*17	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 1.7V	8-pin DFN / 7” Reel (2500)
ZSPM4121AI1*W*21	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 2.1V	8-pin DFN / 7” Reel (2500)
ZSPM4121AI1*W*23	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 2.3V	8-pin DFN / 7” Reel (2500)
ZSPM4121AI1*W*24	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 2.4V	8-pin DFN / 7” Reel (2500)
ZSPM4121AI1*W*25	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 2.5V	8-pin DFN / 7” Reel (2500)
ZSPM4121AI1*W*26	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 2.6V	8-pin DFN / 7” Reel (2500)
ZSPM4121AI1*W*28	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 2.8V	8-pin DFN / 7” Reel (2500)
ZSPM4121AI1*W*30	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 3.0V	8-pin DFN / 7” Reel (2500)
ZSPM4121KIT	ZSPM4121 Evaluation Kit	

* *X* = W for 7” reel with 2500 parts or R for 13” reel with 3300. Custom V_{THRESH} values are also available: 1.2V to 4.2V (typical) in 100mV increments.

Sales and Further Information

www.zmdi.com analog@zmdi.com

Zentrum Mikroelektronik Dresden AG	ZMD America, Inc.	Zentrum Mikroelektronik Dresden AG, Japan Office	ZMD FAR EAST, Ltd.	Zentrum Mikroelektronik Dresden AG, Korean Office
Grenzstrasse 28 01109 Dresden Germany	1525 McCarthy Blvd., #212 Milpitas, CA 95035-7453 USA	2nd Floor, Shinbashi Tokyu Bldg. 4-21-3, Shinbashi, Minato-ku Tokyo, 105-0004 Japan	3F, No. 51, Sec. 2, Keelung Road 11052 Taipei Taiwan	POSCO Centre Building West Tower, 11th Floor 892 Daechi, 4-Dong, Kangnam-Gu Seoul, 135-777 Korea
Phone +49 (0)351.8822 Fax +49 (0)351.8822	Phone +855-ASK-ZMDI (+855.275.9634)	Phone +81.3.6895.7410 Fax +81.3.6895.7301	Phone +886.2.2377.8189 Fax +886.2.2377.8199	Phone +82.2.559.0660 Fax +82.2.559.0700

Contents

List of Figures

List of Tables

1 ZSPM4121 Characteristics

Stresses beyond those listed under "Absolute Maximum Ratings" (section 1.1) may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those recommended under "Recommended Operating Conditions" (section 1.3) is not implied. Exposure to absolute–maximum conditions for extended periods may affect device reliability.

1.1. Absolute Maximum Ratings

Over operating free–air temperature range unless otherwise noted. All voltage values are with respect to network ground terminal.

Table 1.1 Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Maximum voltage applied to the VCC, VOUT,and NPG pins		-0.3 to 6.0	V
Electrostatic Discharge – Human Body Model, according to the respective JESD22 JEDEC standard		2	kV
Operating Junction Temperature Range	T_J	-20 to 85	°C
Storage Temperature Range	T_{stg}	-65 to 150	°C
Lead Temperature (soldering, 10 seconds)		260	°C

1.2. Thermal Characteristics

Table 1.2 Thermal Characteristics for 8-Pin DFN (2mm x 2mm) Package

θ_{JA} (°C/W) 1)	θ_{JC} (°C/W) 2)
73.1	10.7

1) This rating assumes a FR4 board only.

2) This rating assumes a 1oz. copper JEDEC standard board with thermal vias. See section 6.1 for more information.

1.3. Recommended Operating Conditions

Table 1.3 Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Unregulated Supply Input at VCC pin	V_{CC}	1.2		5.5	V
Operating Ambient Temperature 1)	T_A	-20		55	°C
Operating Junction Temperature	T_J	-20		85	°C

1) Operating ambient temperature is only intended as a guideline. The operating junction temperature requirements must not be exceeded.

1.4. Electrical Characteristics

Electrical characteristics for V_{CC} = 1.2V to 5.5 (unless otherwise noted). Minimum and maximum characteristics are tested at T_J = 25°C.

Table 1.4 Electrical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Supply						
Input Supply Voltage at VCC pin	V_{CC}		1.2		5.5	V
Quiescent Current: On Mode	$I_{q\text{-}ON}$	V_{CC} = 5V, no load		70	150	nA
Quiescent Current: Off Mode	$I_{q\text{-}OFF}$	$V_{CC} < V_{THRESH}$, no load		100		pA
Load Switch						
Over-Current Shutdown	I_{OC}	V_{CC} = 5.0V		3		A
Over-Current Retry Period	t_{OC}	V_{CC} = 5.0V		1.7		ms
Output Switch Leakage Current	$I_{LEAK\text{-}SW}$	$V_{CC} < V_{THRESH}$; V_{OUT} grounded		100		pA
Switch ON-Resistance	Rds-on	V_{CC} = 5.0V		175		mΩ
		V_{CC} = 3.3V		200		mΩ
		V_{CC} = 1.8V		350		mΩ
Transition Times						
Transition Delay: On Mode to Off Mode	t_{d1}	V_{OFF} = 2.0V, V_{CC} = 3.0V → 1.5V		650		µs
Transition Delay: Off Mode to On Mode	t_{d2}	V_{OFF} = 2.0V, V_{CC} = 1.5V → 3.0V		1.7		ms
Output Turn-on Rise Time	t_{ON}	V_{CC} = 2.5V, R_{LOAD} = 50Ω		200		µs
NPG Output						
Output Leakage	$I_{LEAK\text{-}NPG}$	V_{CC} = 5.0V, V_{NPG} = 5.5V			100	nA
Low-Level Output Voltage	$V_{OL\text{-}NPG}$	I_{NPG} = 5 mA			0.4	V
Off Thresholds						
Off Threshold	V_{OFF}	V_{THRESH} = customer-selected threshold voltage in the range of 1.2V to 4.2V with 100mV steps between options programmed at manufacturing	0.95 * V_{THRESH}	V_{THRESH}	1.05 * V_{THRESH}	V
Off Mode to On Mode Hysteresis	V_{Hys}	Rising Transition: Off Mode to On Mode		500		mV

2 Typical Performance Characteristics

T = 25°C (unless otherwise noted)

Figure 2.1 On Mode / Off Mode Characteristics

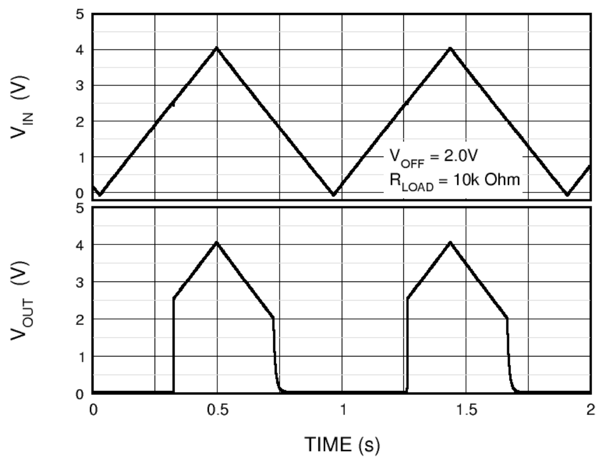


Figure 2.2 On Mode Switching Behavior

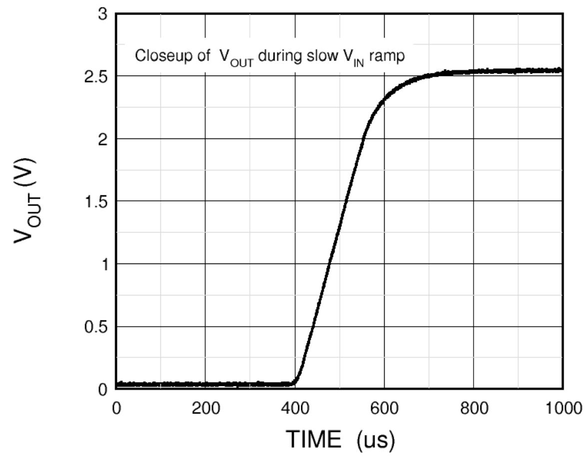


Figure 2.3 On Mode / Off Mode Quiescent Current I_q

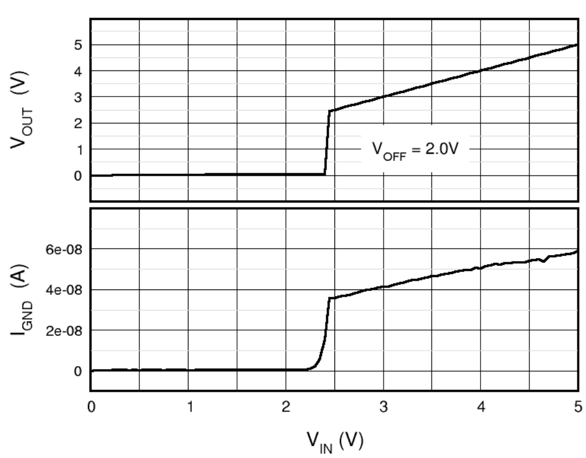


Figure 2.4 Off Mode V_{THRESH} Temperature Performance

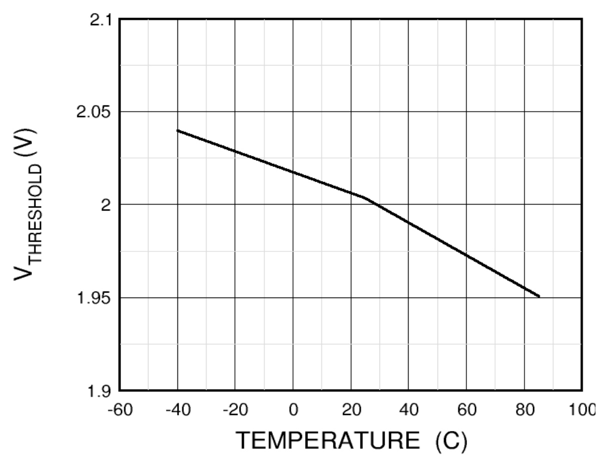


Figure 2.5 On Mode / Off Mode Transition Delay

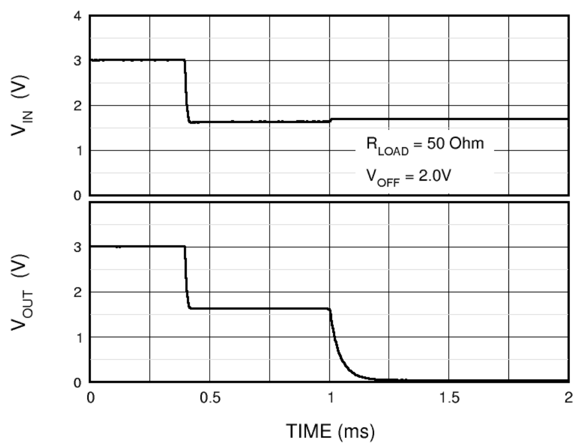
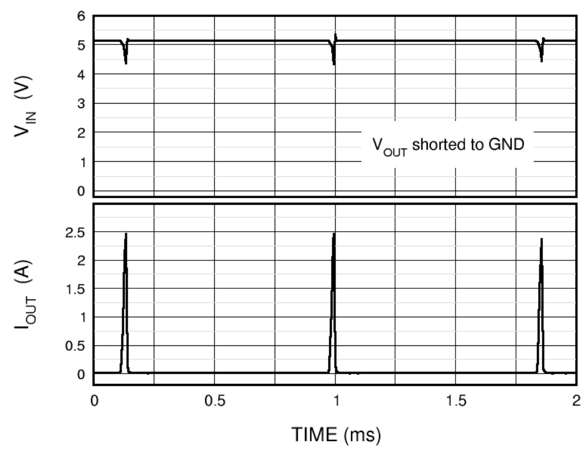


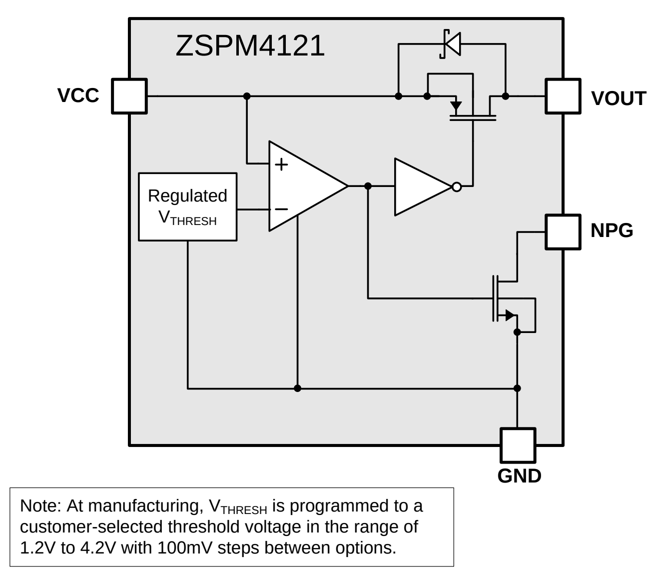
Figure 2.6 Over-Current Retry Performance



3 Description of Circuit

The ZSPM4121 battery management load switch consists of an internally generated threshold voltage, comparator with hysteresis, slew rate control for the load switch, a P-channel load switch, and an open-drain indicator pin. When the input battery voltage is above the factory-configured threshold, the load switch is on (the On Mode). When the input battery voltage falls to the threshold voltage or below, the load switch is off (the Off Mode), and the quiescent current draw on the battery is in the order of 100pA (typical). The ZSPM4121 threshold voltage is programmed at manufacturing to an option in the range of 1.2V to 4.2V with 100mV steps between options. The 500mV hysteresis between the Off Mode and the On Mode prevents intermittent operation. The ZSPM4121 also provides over-current protection.

Figure 3.1 ZSPM4121 Block Diagram



4 Application Circuits

4.1. Typical Application Circuits

Note that when the ZSPM4121 is in Off Mode, the battery will continue to charge through the body diode between VOUT and VCC for the application shown in Figure 4.1.

Figure 4.1 Application Circuit for Disconnecting the Battery

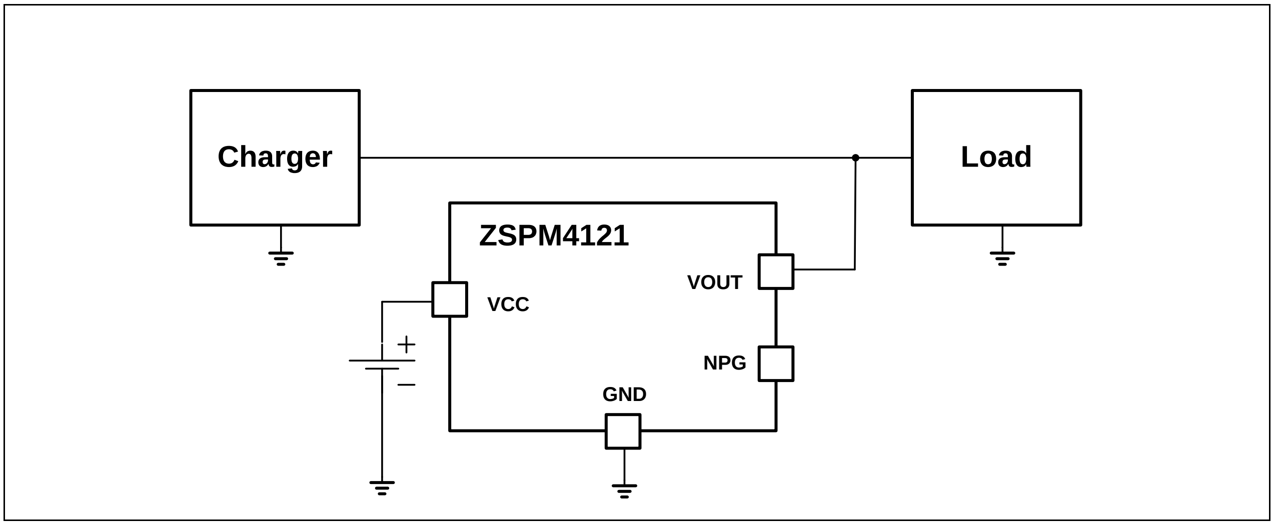
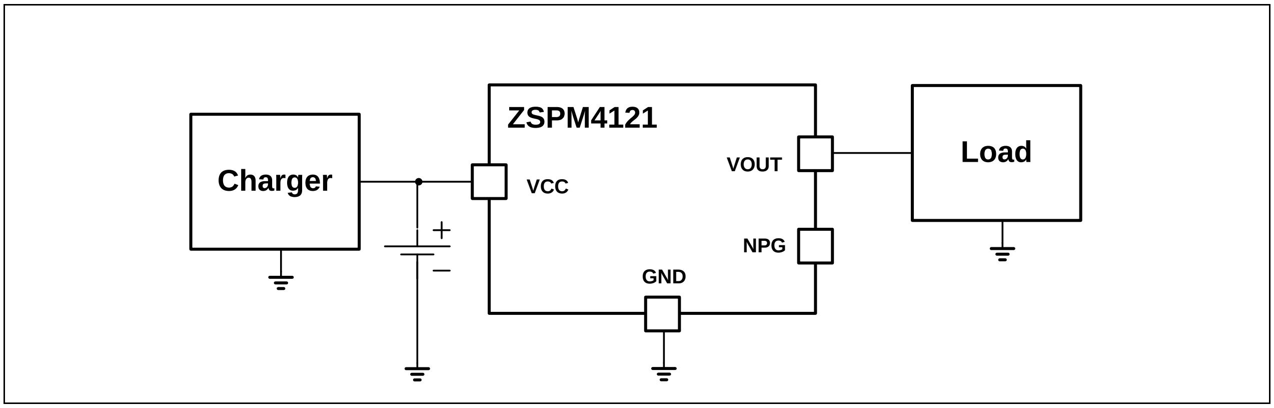


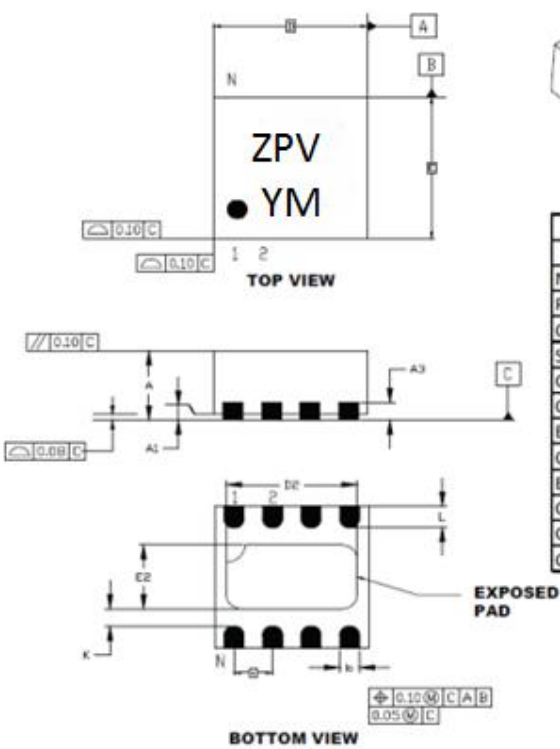
Figure 4.2 Application Circuit for Disconnecting the Load

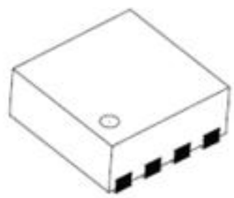


5 Pin Configuration and Package

5.1. Package Dimensions and Marking Diagram

Figure 5.1 ZSPM4121 Package Drawing





Units		MILLIMETERS		
Dimensions Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		0.50 BSC	
Overall Height	A	0.80	0.90	1.00
Standoff	A1	0.00	0.02	0.05
Contact Thickness	A3		0.20 REF	
Overall Length	D		2.00 BSC	
Exposed Pad Width	E2	0.75	0.90	1.00
Overall Width	E		2.00 BSC	
Exposed Pad Length	D2	1.55	1.70	1.80
Contact Width	b	0.18	0.25	0.30
Contact Length	L	0.20	0.30	0.40
Contact-to-Exposed Pad	K	0.20	-	-

Notes:

Dimensions and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

REF: Reference Dimension, usually without tolerance, for information only.

MARKING CODES:

Z: ZMDI
P: Product Code
V: Voltage levels: 1 = 1.2V, 2 = 1.3V, 3 = 1.4V, 4 = 1.5V, 5 = 1.6V, 6 = 1.7V, 7 = 1.8V. 8 = 1.9V, 9 = 2.0V, A = 2.1 V, B = 2,2 V, C = 2.3 V, D = 2.4 V, E - V = 2.5V to 4.2V
YM: Date Code (Year, Month)

5.2. Pin Description for 8-Pin DFN (2x2 mm)

Figure 5.2 ZSPM4121 Pin Assignments (top view)

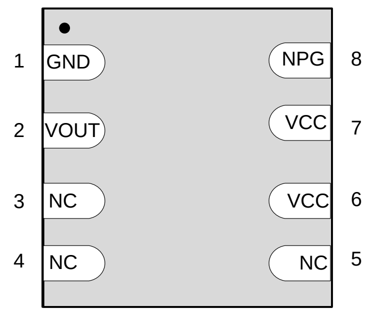


Table 5.1: Pin Description, 8-Pin DFN (2x2)

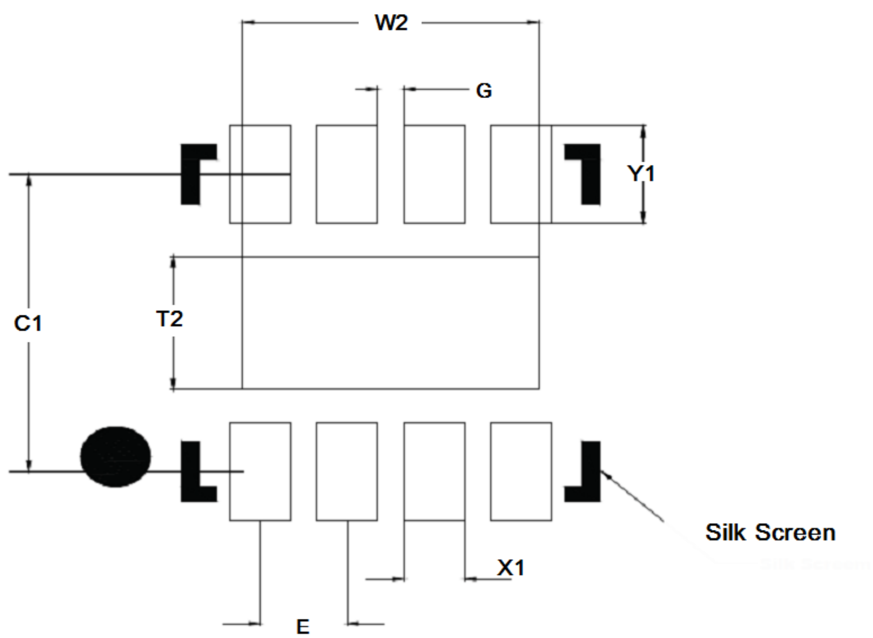
Pin #	Name	Function	Description
1	GND	Ground	GND
2	V_{OUT}	Output	Output to System Load
3	NC		No Connection (connect to GND or float)
4	NC		No Connection (connect to GND or float)
5	NC		No Connection (connect to GND or float)
6	VCC	Supply	Supply Input (connect to pin 7 and VCC supply rail)
7	VCC	Supply	Supply Input (connect to pin 6 and VCC supply rail)
8	NPG	Output	Open-Drain N-Channel Output (low indicates “Power Good”)

6 Layout and Soldering Requirements

To maximize the efficiency of this package for applications on a single layer or multi-layer printed circuit board (PCB), certain guidelines must be followed when laying out this part on the PCB.

6.1. Recommended Landing Pattern for PCBs

Figure 6.1 Recommended Landing Pattern for 8-Pin DFN



	Units	MILLIMETERS		
	Dimension Limits	MIN	NOM	MAX
Contact Pitch	E	0.50 BSC		
Optional Center Pad Width	W2	-	-	1.70
Optional Center Pad Length	T2	-	-	0.90
Contact Pad Spacing	C1	-	2.00	-
Contact Pad Width (X8)	X1	-	-	0.35
Contact Pad Length (X8)	Y1	-	-	0.65
Distance Between Pads	G	0.15	-	-

6.2. Multi-Layer PCB Layout

The following are guidelines for mounting the exposed pad ZSPM4121 on a multi-Layer PCB with ground a plane. In a multi-layer board application, the thermal vias are the primary method of heat transfer from the package thermal pad to the internal ground plane. The efficiency of this method depends on several factors, including die area, number of thermal vias, and thickness of copper, etc.

Figure 6.2 Package and PCB Land Configuration for Multi-Layer PCB

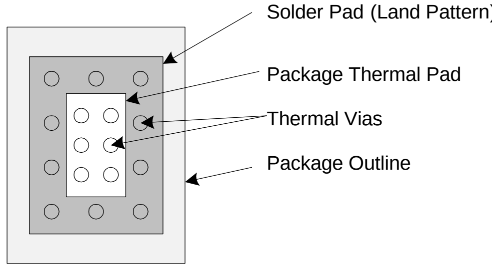


Figure 6.3 JEDEC Standard FR4 Multi-Layer Board – Cross-Sectional View

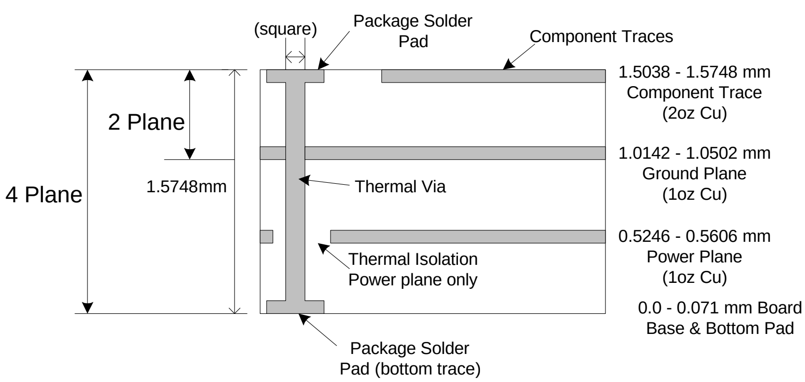
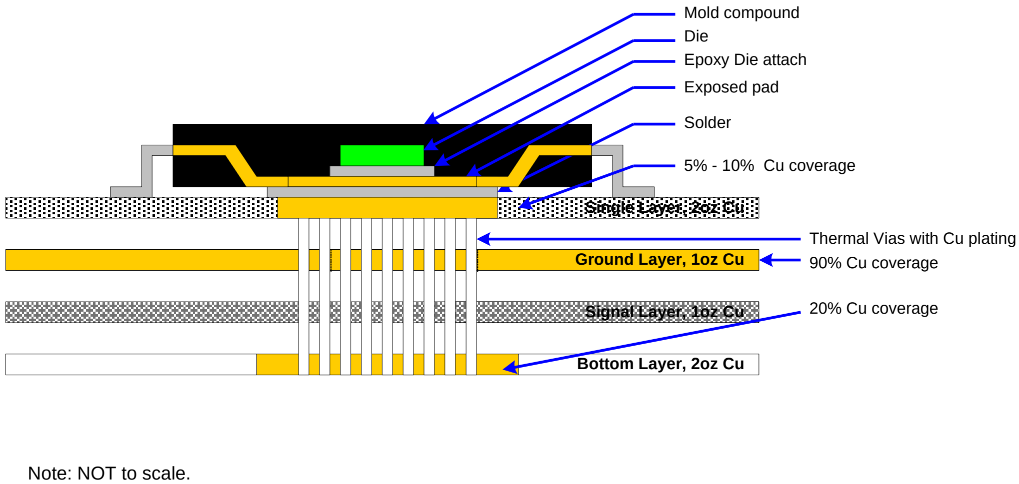


Figure 6.4 is a representation of how the heat can be conducted away from the die using an exposed pad package. Each application will have different requirements and limitations, and therefore the user should use sufficient copper to dissipate the power in the system. The output current rating for the linear regulators might need to be de-rated for ambient temperatures above 85°C. The de-rated value will depend on calculated worst case power dissipation and the thermal management implementation in the application.

Figure 6.4 Conducting Heat Away from the Die using an Exposed Pad Package

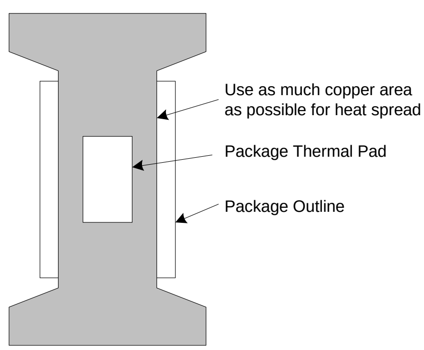


6.3. Single-Layer PCB Layout

Layout recommendations for a single-layer PCB: Utilize as much copper area for power management as possible. In a single-layer board application, the thermal pad is attached to a heat spreader (copper areas) by using a low thermal impedance attachment method (solder paste or thermal conductive epoxy).

In both of the methods mentioned above, it is advisable to use as much copper trace as possible to dissipate the heat.

Figure 6.5 Application Using a Single-Layer PCB



Important: If the attachment method is NOT implemented correctly, the functionality of the product is NOT guaranteed. Power dissipation capability will be adversely affected if the device is incorrectly mounted onto the circuit board.

7 Ordering Information

Ordering Code*	Description	Package
ZSPM4121AI1*W*17	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 1.7V	8-pin DFN / 7" Reel (2500)
ZSPM4121AI1*W*21	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 2.1V	8-pin DFN / 7" Reel (2500)
ZSPM4121AI1*W*23	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 2.3V	8-pin DFN / 7" Reel (2500)
ZSPM4121AI1*W*24	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 2.4V	8-pin DFN / 7" Reel (2500)
ZSPM4121AI1*W*25	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 2.5V	8-pin DFN / 7" Reel (2500)
ZSPM4121AI1*W*26	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 2.6V	8-pin DFN / 7" Reel (2500)
ZSPM4121AI1*W*28	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 2.8V	8-pin DFN / 7" Reel (2500)
ZSPM4121AI1*W*30	ZSPM4121 Under-Voltage Load Switch—V_{THRESH} factory set to 3.0V	8-pin DFN / 7" Reel (2500)
ZSPM4121KIT	ZSPM4121 Evaluation Kit	

* Custom values are also available in the range of 1.2V - 4.2V (typical) in 100mV increments.

8 Related Documents

Document	File Name
ZSPM4121 Feature Sheet	*ZSPM4121_Feature_Sheet_revX_xy.pdf*
ZSPM4121 Evaluation Kit Description	*ZSPM4121_Eval_Kit_Description_revX_xy.pdf*
ZSPM4121 Application Note—Low Power Battery Control and Voltage Regulator Solutions for Remote Sensor Networks	*ZSPM4121_App_Note_LP-Batt-Contr-VReg-Remote-Sensor-Net_X_xy.pdf*

Note: *X_xy* refers to the current revision of the document.

Visit ZMDI's website www.zmdi.com or contact your nearest sales office for the latest version of these documents.

9 Glossary

Term	Description
PG	Power Good (NPG = Power Good, active low)
RFID	Radio Frequency Identification
SPM	Smart Power Management

10 Document Revision History

Revision	Date	Description
1.00	April 30, 2012	First release

Sales and Further Information

www.zmdi.com analog@zmdi.com

Zentrum Mikroelektronik Dresden AG	ZMD America, Inc.	Zentrum Mikroelektronik Dresden AG, Japan Office	ZMD FAR EAST, Ltd.	Zentrum Mikroelektronik Dresden AG, Korean Office
Grenzstrasse 28 01109 Dresden Germany	1525 McCarthy Blvd., #212 Milpitas, CA 95035-7453 USA	2nd Floor, Shinbashi Tokyu Bldg. 4-21-3, Shinbashi, Minato-ku Tokyo, 105-0004 Japan	3F, No. 51, Sec. 2, Keelung Road 11052 Taipei Taiwan	POSCO Centre Building West Tower, 11th Floor 892 Daechi, 4-Dong, Kangnam-Gu Seoul, 135-777 Korea
Phone +49 (0)351.8822 Fax +49 (0)351.8822	Phone +855-ASK-ZMDI (+855.275.9634)	Phone +81.3.6895.7410 Fax +81.3.6895.7301	Phone +886.2.2377.8189 Fax +886.2.2377.8199	Phone +82.2.559.0660 Fax +82.2.559.0700