

YHM2031

Nano Power 1A Ideal Diode

Features

- Input Voltage Range: 1.5V to 5.5V.
- Ultra Low Voltage Drop During Forward biased,
 - 18mV Forward Drop at 100mA (WLP).
 - 50mV Forward Drop at 500mA (WLP).
 - 100mV Forward Drop at 1A (WLP).
- Ultra Low Power Consumption,
 - Low Supply Quiescent Current During Forward biased: 300nA from IN
 - Low Leakage Current During Reverse biased: 10nA from IN.
- Tiny Package,
 - Tiny 4-bumps 0.67mm x 0.75mm WLCSP
 - 5-Pin SOT23
- Thermal shutdown function.
- Over Current Protection.

Applications

- Battery Power Backup System
- Wearable device
- USB Powered Device
- Portable Medical Device

General Description

The YHM2031 is an ideal diode with ultra-low power consumption and ultra-low forward voltage. Its working voltage range is from 1.5V to 5.5V and it can carry up to 1A forward current. Typical voltage drop is 50mV at 500mA output current, with the voltage drop increasing linearly at higher current.

The YHM2031 integrates over current function and open switch to protect downstream circuit when its switch current becomes too large. And it has thermal protection to protect itself when its junction temperature becomes too high.

When the YHM2031 is disabled (EN=0, A version is EN=1), it blocks both directions up to 6V.

The YHM2031 is available in tiny 4 bumps 0.67mm x 0.75mm WLCSP and 5 pins SOT23-5 package. It operates over an ambient temperature range of - 40°C to + 85°C.

Typical Application

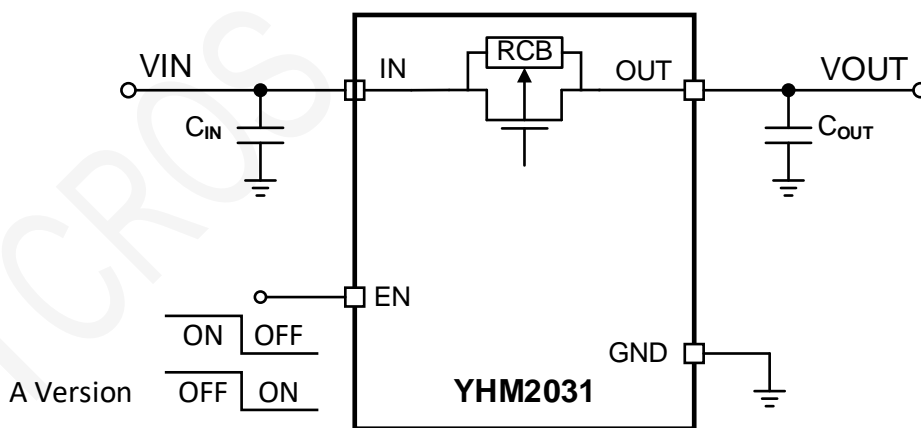


Figure 1. YHM2031 Application Diagram

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Internal Block Diagram

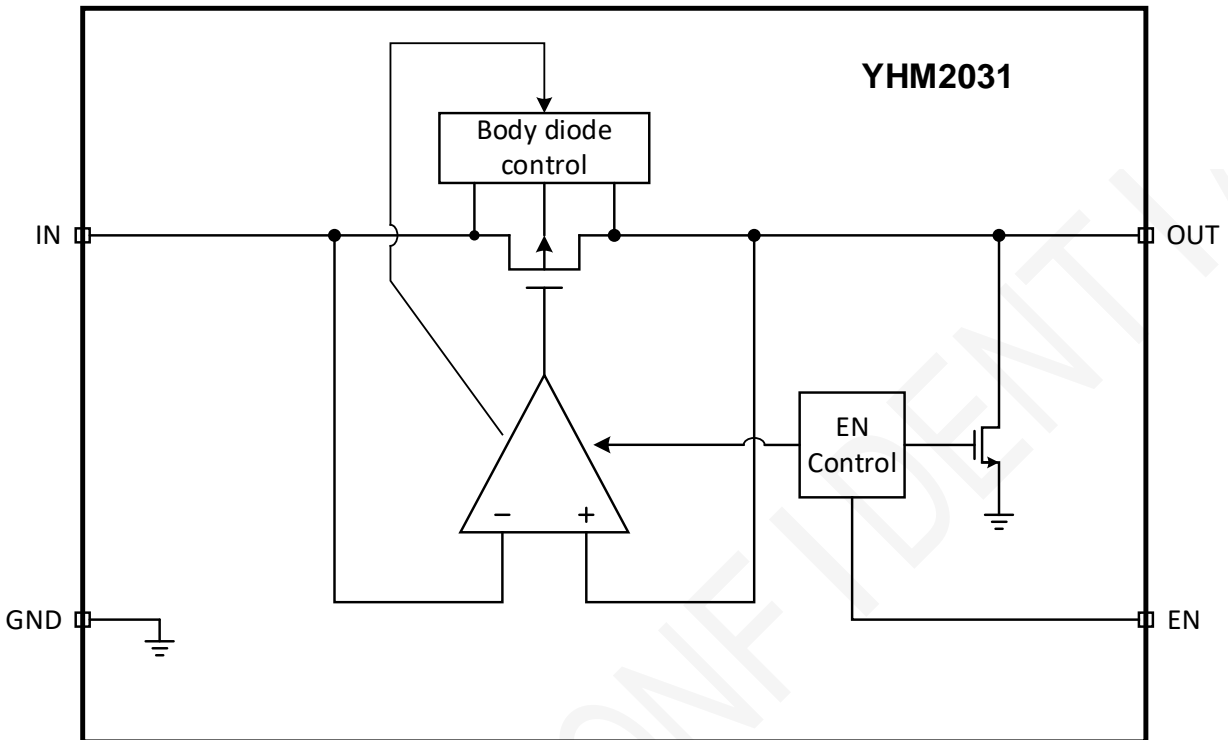


Figure 2. YHM2031 Functional Block Diagram

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Pin Configurations

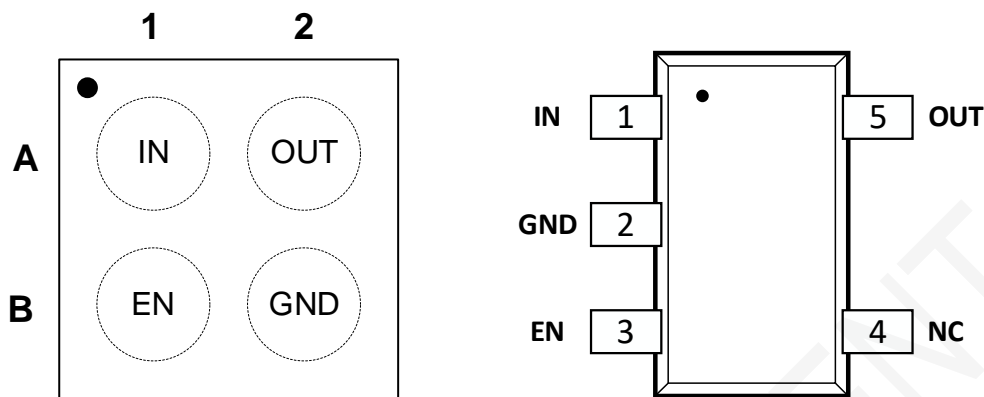


Figure 3. YHM2031 Pin Assignment. (Top View)

YHM2031 Pin Descriptions

WLP	SOT23	Name	Description
A1	1	IN	Device Power supply and voltage input pin.
A2	5	OUT	Voltage output pin.
B1	3	EN	Device enable pin. Device is active when EN = 1. Internal weakly pull up. Device is active when EN = 0 in A version. Internal weakly pull down.
B2	2	GND	Ground
-	4	NC	No Connection

1 Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter		Min.	Max.	Unit
V_{IN}	IN to GND		-0.3	6	V
V_{OUT}	OUT to GND		-0.3	6	V
V_{EN}	OUT to GND		-0.3	6	V
I_{OUT}	Output Current			1.5	A
T_{STG}	Storage Temperature Range		-65	+150	°C
T_J	Maximum Junction Temperature			+150	°C
ESD	Human Body Model, ANSI/ESDA/JEDEC JS-001-2012	All Pins	6.5		KV
	Charged Device Model, JESD22-C101	All Pins	2		

Note 1. Refer to JEDEC JESD51-7, use a 4-layerboard.

2 Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance.

Parameters	Min.	Max.	Unit
Input Voltage: V_{IN}	1.5	5.5	V
Output Current: I_{OUT}		1	A
Operating Ambient Temperature Range	-40	85	°C

3 Electrical Characteristics

Condition: $V_{DD} = 5V$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$. $C_{IN} = C_{OUT} = 10\mu F$, Typical values are at $T_A = +25^{\circ}C$, unless otherwise noted.

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Input Voltage Range	V_{IN}		1.5		5.5	V
Output Current	I_{OUT}				1	A
Quiescent Current into IN	I_{QIN}	EN = 1, $I_{OUT} = 0A$, forward biased		300	500	nA
		EN = 1, $I_{OUT} = 0A$, $V_{IN} = 2V$, $V_{OUT} = 5V$, reverse biased		15	200	
Quiescent Current into OUT	I_{QOUT}	EN = 1, $I_{OUT} = 0A$, $V_{IN} = 2V$, $V_{OUT} = 5V$, reverse biased, $T_A = 25^{\circ}C$		350	900	nA
Shut Down Current into IN	I_{SHUT_IN}	EN = 0, $I_{OUT} = 0A$, forward biased		130	600	nA
		EN = 0, $I_{OUT} = 0A$, $V_{IN} = 2V$, $V_{OUT} = 5V$ reverse biased		10	150	
Shut Down Current into OUT	I_{SHUT_OUT}	EN = 0, $I_{OUT} = 0A$, $V_{IN} = 0V$, $V_{OUT} = 5V$ reverse biased		130	600	nA
Forward Voltage	V_{FW}	$I_{FW} = 1mA$, WLP		16	35	mV
		$I_{FW} = 100mA$, WLP		18		
		$I_{FW} = 200mA$, $V_{IN} = 5V$, WLP		TBD		
		$I_{FW} = 500mA$, WLP		50		
		$I_{FW} = 1A$, WLP		100	180	

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
		$I_{FW} = 1\text{mA}$, SOT23		16	35	
		$I_{FW} = 100\text{mA}$, SOT23		TBD		
		$I_{FW} = 200\text{mA}$, $V_{IN} = 5\text{V}$, SOT23		TBD		
		$I_{FW} = 500\text{mA}$, SOT23		TBD		
		$I_{FW} = 1\text{A}$, SOT23		TBD		
EN Input Logic High	V_{IH}		0.9			V
EN Input Logic Low	V_{IL}				0.3	V
EN Input Current at Logic Low	I_{ENL}	$V_{EN} = \text{GND}$, $T_A = 25^\circ\text{C}$		0.5		μA
Power Up Time	t_{PUPD}	$C_{OUT} = 10\mu\text{F}$, $R_L = 3.3\text{K}$		400		μs
Enable Time	t_{EN}	$C_{OUT} = 10\mu\text{F}$, $I_{FW} = 100\text{mA}$		300		μs
Disable Time	t_{DIS}	$C_{OUT} = 10\mu\text{F}$, $I_{FW} = 100\text{mA}$		80		μs
Thermal Protection Threshold	T_{SD}			150		$^\circ\text{C}$
Thermal Protection Hysteresis	T_{HYS}			20		$^\circ\text{C}$

4 Detailed Description

4.1 General Introduction

The YHM2031 is a near ideal diode. The device blocks reverse voltage and current. And it passes current when it forward biased. However, instead of a around 600mV forward voltage drop in real diode, the ideal diode exhibit a near constant voltage to current ratio. This voltage drop is around 40mV at 500mA of forward current.

The YHM2031 features an active-high (A version is active low) enable input (EN) that allows the forward current path to be turned off when not required. The device is disabled when EN is low, and the ideal diode blocks voltages on either side to a maximum of 6V above ground. The EN input has an internal weak pullup (A version has pull down), it can be left open or connect to IN for normal operation.

4.1.1 Operation Mode

YHM2031 has designed for current direction from IN to OUT. So when $V_{IN} > V_{OUT}$, the device is forward-biased.

YHM2031's operation is like below:

- 1) The switch is on when YHM2031 is forward-biased.
- 2) The switch is off when YHM2031 is reverse-biased.
- 3) The switch is off when junction temperature is higher than thermal shutdown threshold.
- 4) The switch if off when $EN=0$ or $EN=1$ in A version.

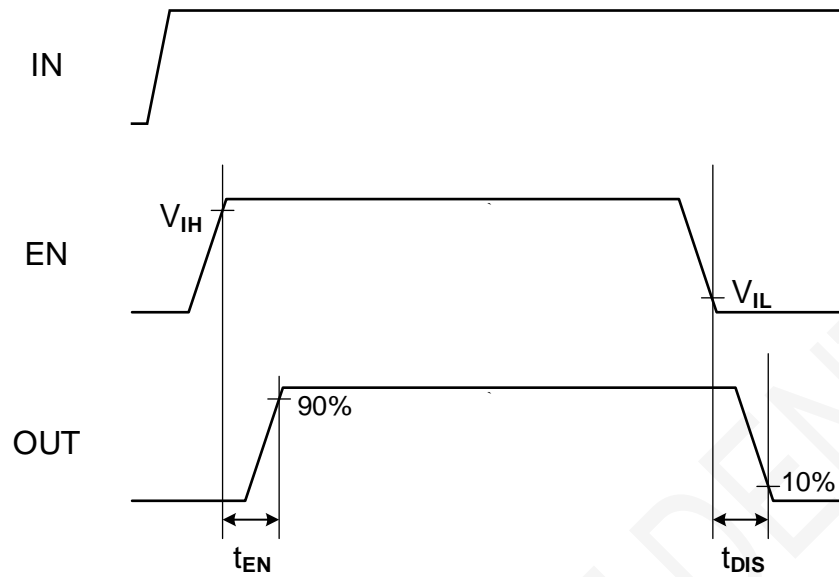


Figure 4. EN Control Timing (Normal version)

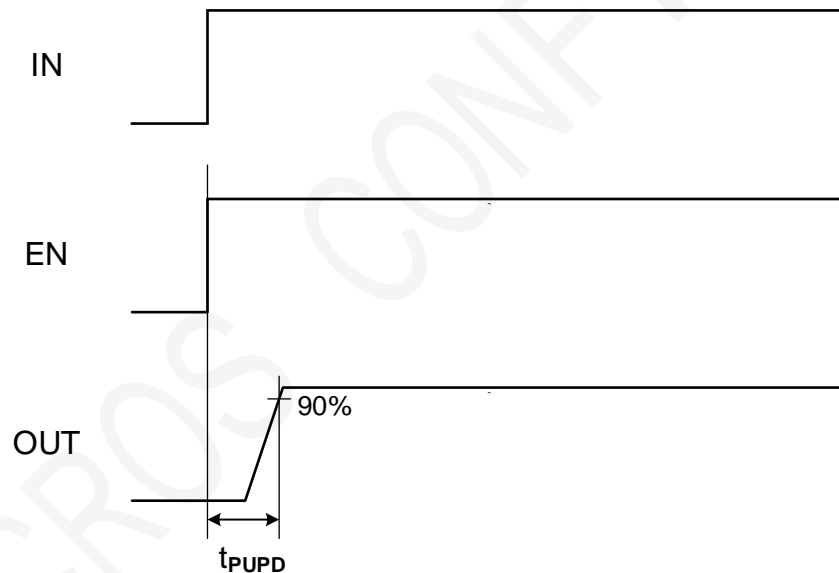


Figure 5. Power Up Timing (Normal version)

4.1.2 Output Current Limit and Thermal Protection

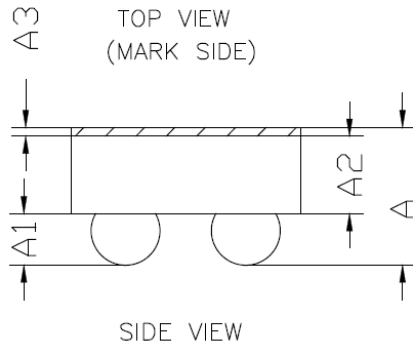
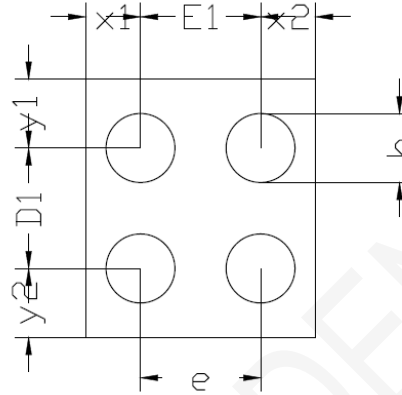
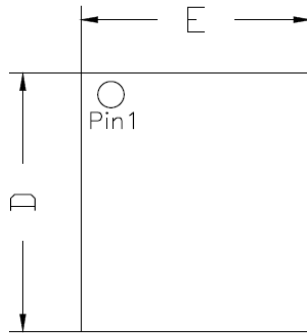
YHM2031 has thermal shutdown function. When the junction temperature exceeds T_{SD} , the device turns off internal MOSFET to protect itself. The device exits thermal shutdown after junction temperature cools down below $T_{SD}-T_{HYS}$. And then the device full works after a soft start period. The device is designed to support 1A maximum forward current capability. The load can drop more current from the source which pass through YHM2031, but it is not suggested. There is current limit circuit for final protection in large current application. If the forward current larger than 1.5A and the device would cut off and retry close after 100ms. Finally, the device will touch the thermal protection.

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5 Package Dimensions

0.67mm x 0.75mm WLCSP



TOP VIEW
(MARK SIDE)

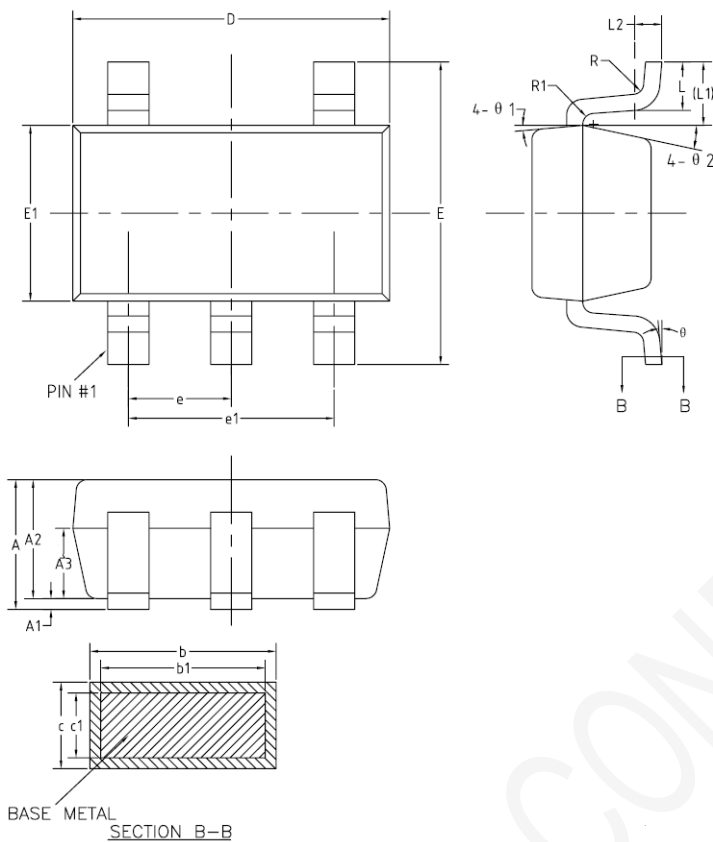
BOTTOM VIEW
(BUMP SIDE)

COMMON DIMENSIONS (UNITS OF MEASURE=MILLIMETER)			
SYMBOL	MIN	NOM	MAX
A	0.352	0.400	0.448
A1	0.130	0.150	0.170
A2	0.200	0.225	0.250
A3	0.022	0.025	0.028
D	0.730	0.750	0.770
D1	0.350BSC		
E	0.650	0.670	0.690
E1	0.350BSC		
b	0.180	0.200	0.220
e	0.350		
x1	0.160 REF		
x2	0.160 REF		
y1	0.200 REF		
y2	0.200 REF		

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SOT23-5



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	—	—	1.25
A1	0	—	0.15
A2	1.00	1.10	1.20
A3	0.60	0.65	0.70
b	0.36	—	0.50
b1	0.36	0.38	0.45
c	0.14	—	0.20
c1	0.14	0.15	0.16
D	2.826	2.926	3.026
E	2.60	2.80	3.00
E1	1.526	1.626	1.726
e	0.90	0.95	1.00
e1	1.80	1.90	2.00
L	0.35	0.45	0.60
L1	0.59REF		
L2	0.25BSC		
R	0.10	—	—
R1	0.10	—	0.25
θ	0°	—	8°
θ 1	3°	5°	7°
θ 2	6°	—	14°

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6 Ordering Information

Part Number	Package	Top Mark (Note 1)	EN logic	MOQ
YHM2031W4T	4 WLCSP	XX	High	5000
YHM2031S5T	5 SOT23	Y2031 YYWW	High	3000
YHM2031AW4T	4 WLCSP	XX	Low	5000
YHM2031AS5T	5 SOT23	2031A YYWW	Low	3000

T = Tape and reel.

Note 1: Letter x is production date code. YY: Production year, WW: Production week.

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7 Datasheet Change History

Rev	Date	Changes
0.0	Sep.2024	Initial Version