AP4400A
Ultra Low Power Voltage Detector

1. Genaral Description

The AP4400A is ultra-low power consumption and high-precision IC for voltage detection. Its consumption current is extremely low and is only 20nA typically (@3.3 V, detecting voltage). Since its consumption current is much low during the voltage monitoring, AP4400A is ideal for energy harvesting application.

2. Features

- "H" Level Detection Voltage (V_{VDETH}):   2.0 to 4.2V (0.1V step for option)
- "L" Level Detection Voltage (V_{VDETL}):   1.8 to 4.0V (0.1V step for option)
- Hysteresis Voltage: 0.2 to 2.4 V
- Operation Voltage Range   0.8 to 5.5V
- Consumption Current   20 nA typical (@V_{VDDIN} = 3.4 V)
- Operation temperature   Ta = -15 ～ 85 °C
- Package Type   TMSOP 10-pin

<div style="border:1px solid black; padding:8px;">

3. Table of Contents

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4. Block Diagram

■ Block Diagram

AP4400A : CMOS output type (Active "H")
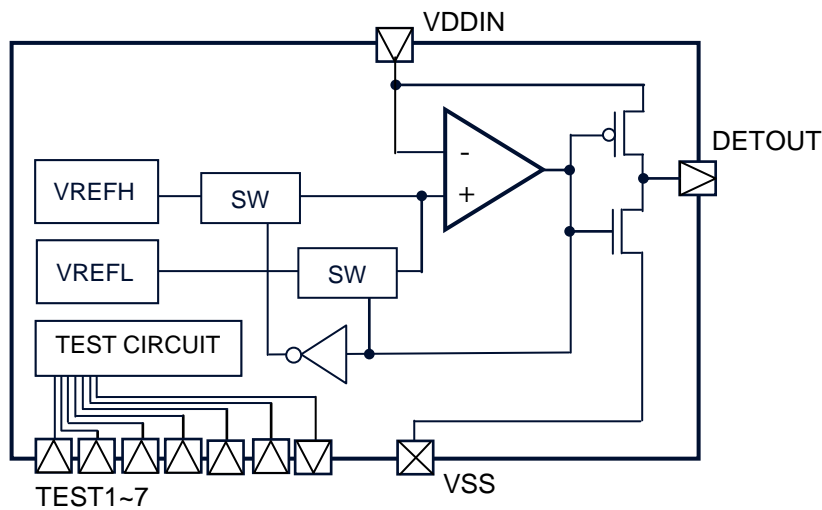

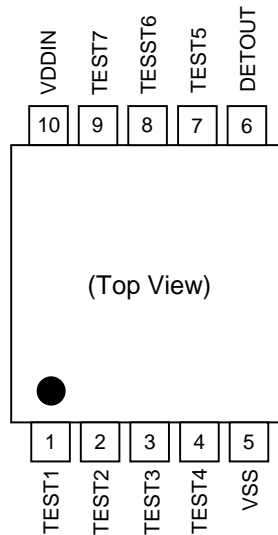Figure 1. Block Diagram

5. Ordering Guide

AP4400AEMNM   -15 to 85°C   TMSOP 10-pin

Please refer to section 12.Part Number Code for voltage option.

6. Pin Configurations and Functions

■ **Pin Configurations**

TMSOP 10-pin

(Top View)

■ **Function**

Pin No.	Name	I/O (Note 1)	Function
1	TEST1	IN	Connect to VSS.
2	TEST2	IN	Connect to VSS.
3	TEST3	IN	Connect to VSS.
	TEST4	IN	Connect to VSS.
5	VSS	PWR	GND pin
6	DETOUT	OUT	Voltage detect output pin
7	TEST5	OUT	No Connection (Need to be Open).
8	TEST6	IN	Connect to VSS.
9	TEST7	IN	Connect to VSS.
10	VDDIN	PWR	Power pin

Note 1. PWR: Power pin (VSS or VDDIN).

7. Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit
Power Supply (Note 2)	V_{VDDIN}	-0.3	6.5	V
Output Voltage (Note 2)	V_{out}	V_{VSS} -0.3	V_{VDDIN} + 0.3	V
Output Current	I_{out}	-10	+10	mA
Power Dissipation	Pd	-	1.0	W
Storage Temperature	T_{stg}	-55	150	°C

Note 2. All voltages are with reference to $V_{VSS} = 0$ V.

WARNING: Stresses exceeding Maximum Ratings may damage the device. Normal operation is not guarantee if the condition exceeds the maximum rating.

8. Recommended Operating Conditions

Parameter	Symbol	min	typ	max	Unit	Condition
Operation Temperature	T_a	-15	-	85	°C	-
Power Voltage (Note 3)	V_{VDDIN}	0.8	-	5.5	V	-

Note 3. The output is infinite in under the condition: $V_{VDDIN} \leq 0.8$ V, adequate evaluation including temperature characteristics is necessary.

9. Electrical Characteristics

Ta = 25°C, DETOUT = open, unless otherwise specified.

Parameter	Symbol	min	typ	max	Unit	Condition
Detecting voltage (Note 4)						
"H" Level voltage	V_{VDETH}	3.2	3.3	3.4	V	V_{VDDIN} = "L"→"H"
"L" Level voltage	V_{VDETL}	1.9	2.0	2.1	V	V_{VDDIN} = "H"→"L"
Detection voltage temperature coefficient	$\Delta V_{DET}/\Delta Ta$	-	0.75	-	mV/°C	Ta=-15 ～85°C
Consumption current (Note 5)						
In V_{VDDIN} Rising	I_{DDH}	-	20	50	nA	V_{VDDIN} = V_{VDETH}+0.1V
In V_{VDDIN} Falling	I_{DDL}	-	20	50	nA	V_{VDDIN} = V_{VDETL} -0.1V
Level "L" output current (Note 6)	I_{OL}	0.2	-	-	mA	V_{VDDIN} = V_{VDETL} -0.1V, V_{VDDIN} - V_{DETOUT} =0.5V
Level "H" output current (Note 6)	$I_{OH}1$	0.15	-	-	mA	V_{VDDIN} = V_{VDETH} +0.1V, V_{DETOUT} - V_{VSS} =0.5V
Minimum operating voltage (Note 7)	V_{OPL}	-	0.4	0.8	V	
Output response (Note 4)	tPLH	-	0.12	0.25	ms	V_{VDDIN} = V_{VDETH} -0.1V→V_{VDETH} +0.1V
	tPHL	-	25	40	ms	V_{VDDIN} = V_{VDETL} +0.1V→V_{VDETL} -0.1V

Note 4. Example of detecting voltage. When ordering the product, specify the voltage. The voltage can be set in the range between 1.8 and 4.2 V in units of 0.1 V by taking into account the hysteresis voltage.

Note 5. It does not include the current for the output drive.

Note 6. Since the output current depends on V_{VDDIN}, adequate evaluation including the temperature characteristics are necessary.

Note 7. It indicates the lowest Power Voltage value in case of detected output voltage is less than 0.4V.

10. Description

- **Operation in the Voltage (V_{VDDIN}) Rising:**
  When V_{VDDIN} is between V_{VSS} and the minimum operating voltage of IC, the V_{DETOUT} output is indefinite. When V_{VDDIN} is above the minimum operating voltage, V_{DETOUT} outputs V_{VSS}. When V_{VDDIN} is reached to V_{VDETH}, V_{DETOUT} outputs V_{VDDIN}.

- **Operation in the Voltage (V_{VDDIN}) Falling:**
  When V_{VDDIN} is above V_{VDETH}, V_{DETOUT} outputs V_{VDDIN}. When V_{VDDIN} is below V_{VDETL}, V_{DETOUT} outputs V_{VSS}. V_{DETOUT} output becomes indefinite, when V_{VDDIN} is below the minimum operating voltage.
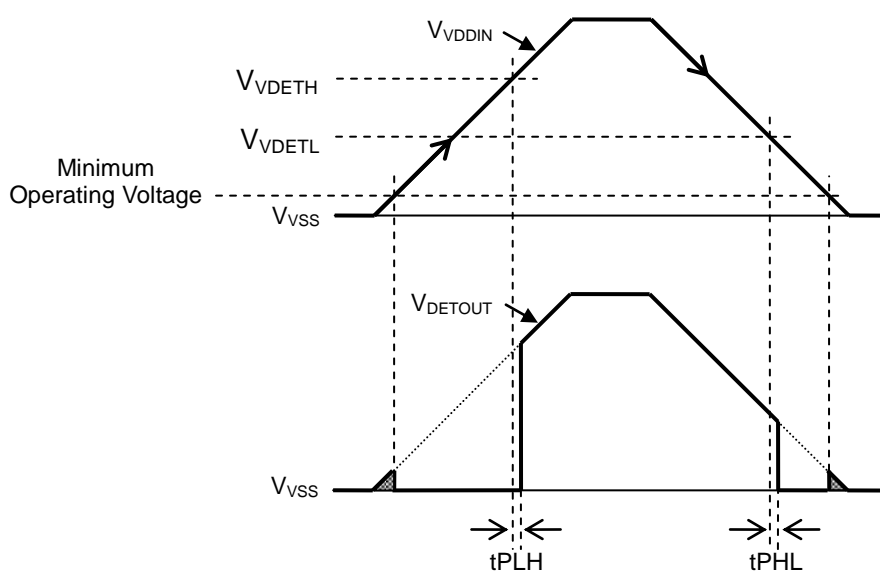

Figure 2. Operation Detail
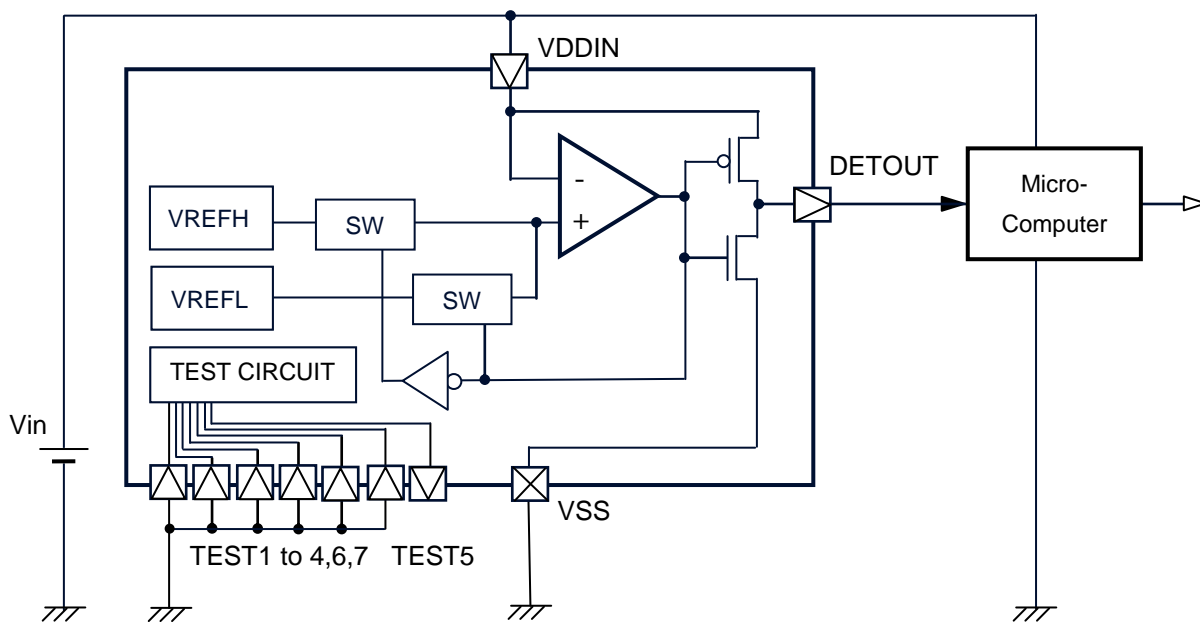
11. Recommended External Circuits

Figure 3. Typical Application Diagram

Note 8. Connect the capacitor Cin between VDDIN and VSS terminals if V_{VDDIN} is dropped with V_{DETOUT} inversion.

12. Part Number Code

The detecting voltage can be selected for the AP4400A. The definition of each option is shown as below:
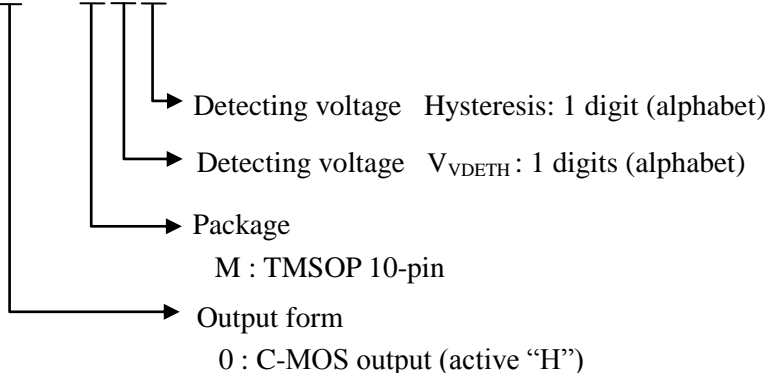
■ **Product name**

AP440XAEXXX

→ Detecting voltage Hysteresis: 1 digit (alphabet)

→ Detecting voltage V_{VDETH} : 1 digits (alphabet)

→ Package
   M : TMSOP 10-pin

→ Output form
   0 : C-MOS output (active "H")

Table 1. Voltage Option

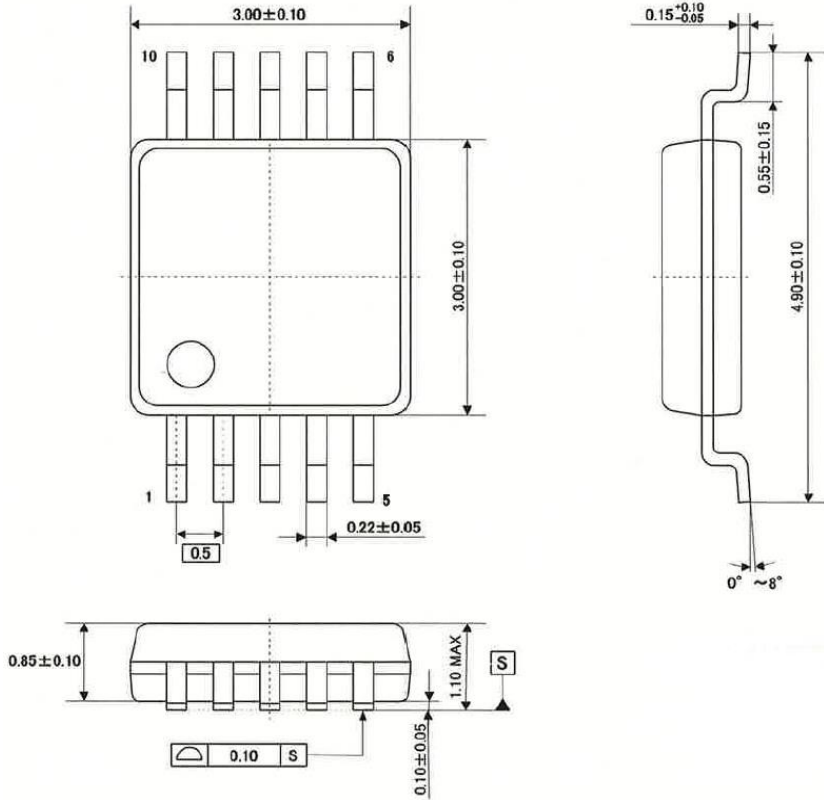|	V_{VDETH}	Hysteresis $(V_{VDETH} - V_{VDETL})$
A	2.0	-
B	2.1	0.2
C	2.2	0.3
D	2.3	0.4
E	2.4	0.5
F	2.5	0.6
G	2.6	0.7
H	2.7	0.8
I	2.8	0.9
J	2.9	1.0
K	3.0	1.1
L	3.1	1.2
M	3.2	1.3
N	3.3	1.4
O	3.4	1.5
P	3.5	1.6
Q	3.6	1.7
R	3.7	1.8
S	3.8	1.9
T	3.9	2.0
U	4.0	2.1
V	4.1	2.2
W	4.2	2.3
X	-	2.4

■ **Part number code example**

Package : TMSOP 10-pin, V_{VDETH} = 3.3 V, Hysteresis($V_{VDETH} - V_{VDETL}$)= 1.3 V
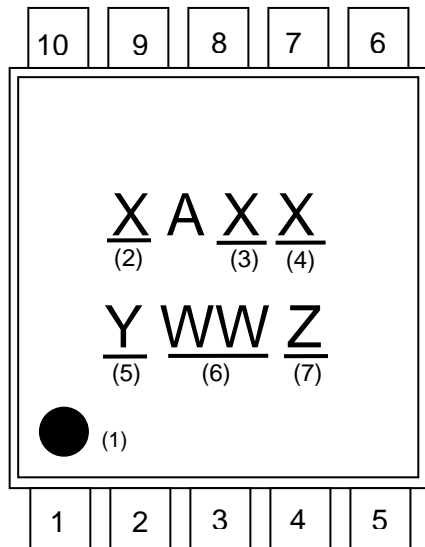
Part number code : AP4400AEMNM

13. Package

■ Outline Dimensions

(Unit: mm)

■ Marking

(1) Pin 1 display
(2) Output type
(3) Detecting voltage (V_{VDETH})
(4) Hysteresis
(5) Year code (last 1 digit)
(6) Week code
(7) Management code

14. Revise History

Date (YY/MM/DD)	Revision	Page	Contents
14/04/17	00		First edition
14/08/27	01	P9	Correction of the explanation of product name (6th digit and last 2 digits).
15/03/04	02	P6	Error correction.

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