HIGH-SENSITIVITY ULTRA-LOW POWER DIGITAL UNIPOLAR HALL-EFFECT SWITCH

Description

The AH1381/AH1382/AH1383 is an ultra-low power digital Unipolar Hall-effect switch IC from Diodes Incorporated's broad Hall-effect switches family. Thanks to the hibernating clocking system, the average supply current is only 1.6μA at 3V, which makes the AH1381/AH1382/AH1383 perfectly fit battery-powered consumer products, gas or water meters, smoke detectors and IoT devices. The wider range of the supply voltage (1.6V to 5.5V) extends battery operating time and supports low-voltage system microcontrollers, which provides great flexibility for system design. The advanced chopper stabilized design provides superior stability on switch operating point over temperature and supply voltage. The high ESD level up to 8kV helps to improve the system robustness.

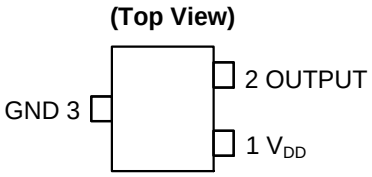
The output is activated with south pole of sufficient magnetic field strength. When the magnetic flux density (B) perpendicular to the package is larger than operate point (B_{OPS}), the output will be turned on (pulled low) and held until B is lower than release point (B_{RPS}).

The devices are packaged in SOT23 (Type S) and small low profile X2-DFN1410-4 and X2-DFN1010-4 (Type B).

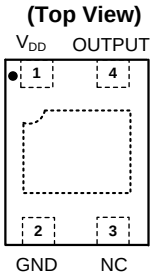
Features

- Unipolar Operation (South Pole)
- Supply Voltage of 1.6V to 5.5V
- Micro Power Operation
- Chopper Stabilized Design Provides:
  - Superior Temperature Stability
  - Minimal Switch Point Drift
  - Enhanced Immunity to Physical Stress
- No External Pullup Resistors Required
- Good RF Noise Immunity
- -40°C to +85°C Operating Temperature
- High ESD Capability of 8kV (Human Body Model)
- Small Low Profile SOT23 (Type S), X2-DFN1410-4 and X2-DFN1010-4 (Type B) Packages
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative. https://www.diodes.com/quality/product-definitions/**

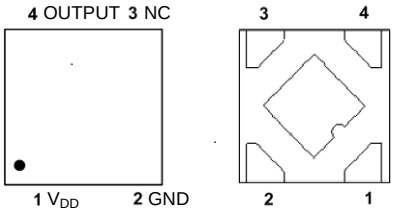
Pin Assignments



SOT23 (Type S)



X2-DFN1410-4



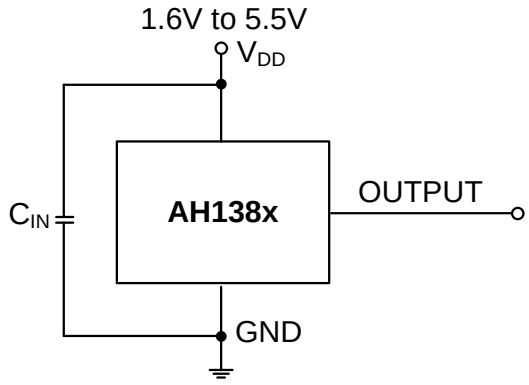
X2-DFN1010-4 (Type B)

Applications

- Smart covers for cellular phones, tablets, laptops, Chromebooks
- Open and close detect for TWS, digital still/video cameras and handheld gaming consoles
- Medical devices, IoT systems
- Level, proximity and position switches
- E-locks, smoke detectors, appliances
- Doors, lids and tray position switches
- Home appliances such as washing machines, refrigerators
- Industrial applications such as smart meters, E-meters, power tools

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Typical Applications Circuit



Note: 4. C_{IN} is for power stabilization and to strengthen the noise immunity, the recommended capacitance is 100nF typical and should be placed as close to the supply pin as possible.

Pin Descriptions

(1) Package: SOT23 (Type S)

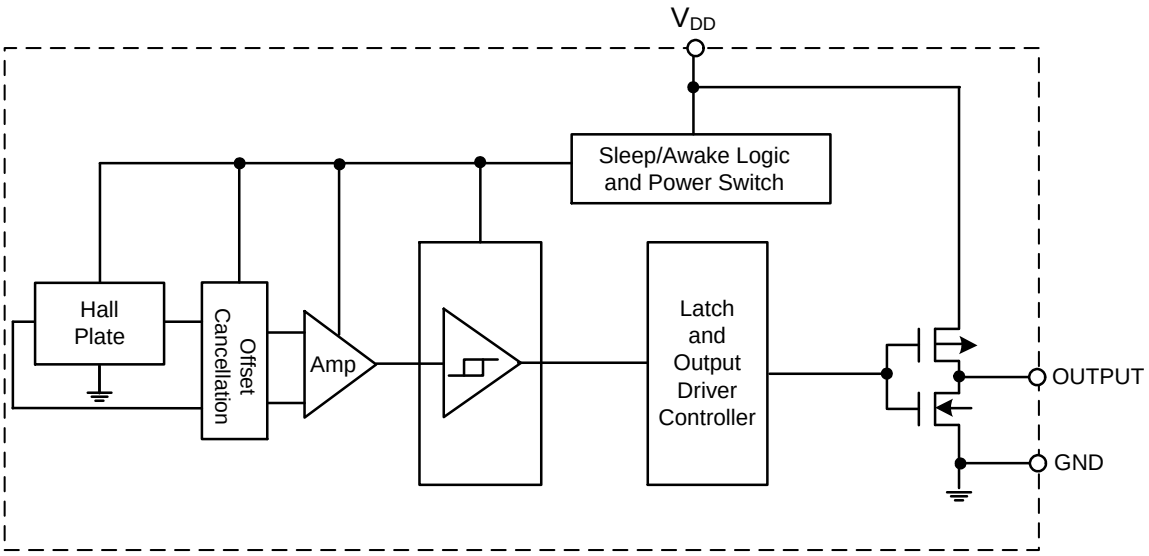
Pin Number	Pin Name	Function
1	V_{DD}	Power Supply Input
2	OUTPUT	Output Pin
3	GND	Ground Pin

(2) Packages: X2-DFN1410-4, X2-DFN1010-4 (Type B)

Pin Number	Pin Name	Function
1	V_{DD}	Power Supply Input
2	GND	Ground Pin
3	NC	No Connection (Note 5)
4	OUTPUT	Output Pin
Pad	Pad	The center exposed pad – No connection internally. The exposed pad can be left open (unconnected to) on the PCB layout.

Note: 5. NC is “No Connection” pin and is not connected internally. This pin can be left open or tied to ground.

Functional Block Diagram



Absolute Maximum Ratings (Note 6) (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter		Rating	Unit
V_{DD}	Supply Voltage (Note 7)		6	V
V_{DD_REV}	Reverse Supply Voltage		-0.3	V
I_{OUTPUT}	Output Current (Source and Sink)		1	mA
B	Magnetic Flux Density		Unlimited	
P_D	Package Power Dissipation	SOT23 (Type S) and X2-DFN1410-4	230	mW
		X2-DN1010-4 (Type B)	400	
T_S	Storage Temperature Range		-65 to +150	°C
T_J	Maximum Junction Temperature		+150	°C
ESD HBM	Human Body Model (HBM) ESD Capability		8	kV

Notes: 6. Stresses greater than those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to *Absolute Maximum Ratings* for extended periods can affect device reliability.

7. The absolute maximum V_{DD} of 6V is a transient stress rating and is not meant as a functional operating condition. It is not recommended to operate the device at the absolute maximum rated conditions for any period of time.

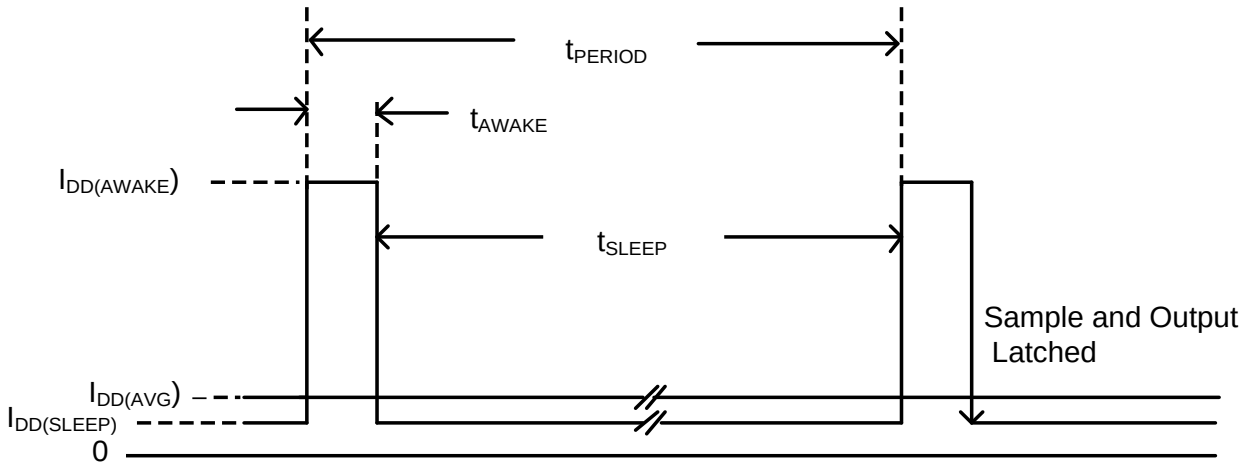
Recommended Operating Conditions (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Conditions	Rating	Unit
V_{DD}	Supply Voltage	Operating	1.6V to 5.5V	V
T_A	Operating Temperature Range	Operating	-40 to +85	°C

Electrical Characteristics (@T_A = +25°C, V_{DD} = 3V, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OL}	Output Low Voltage (On)	I_{OUT} = 1mA	—	0.15	0.25	V
V_{OH}	Output High Voltage (Off)	I_{OUT} = -1mA	V_{DD}-0.25	V_{DD}-0.15	—	V
$I_{DD(AWAKE)}$	Supply Current	T_A = +25°C, V_{DD} = 3V	—	1	1.5	mA
		T_A = -40 to +85°C, V_{DD} = 1.6V to 5.5V	—	1	3	mA
$I_{DD(SLEEP)}$	Supply Current	T_A = +25°C, V_{DD} = 3V	—	0.6	1	µA
		T_A = -40 to +85°C, V_{DD} = 1.6V to 5.5V	—	0.6	3	µA
$I_{DD(AVG)}$	Average Supply Current	T_A = +25°C, V_{DD} = 3V	—	1.6	3	µA
		T_A = -40 to +85°C, V_{DD} = 1.6V to 5.5V (Note 8)	—	1.6	9	µA
t_{AWAKE}	Awake Time	(Note 9)	30	45	80	µs
t_{PERIOD}	Period	(Note 9)	30	45	80	ms
D.C.	Duty Cycle	—	—	0.1	—	%

Notes: 8. Typical data is at T_A = +25°C, V_{DD} = 3V.
9. When power is initially turned on, the operating V_{DD} (1.6V to 5.5V) must be applied to guaranteed the output sampling. The output state is valid after the second operating cycle (typical 90ms).

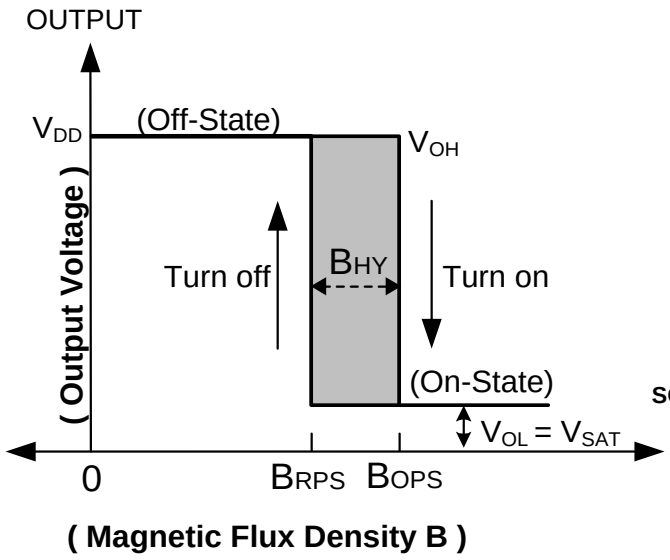


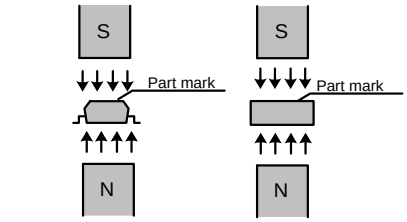
Magnetic Characteristics (Note 10) (T_A = +25°C, V_{DD} = 3V, unless otherwise specified.)

(1mT=10 Gauss)

Part Number	Symbol	Parameter	Condition	Min	Typ	Max	Unit
AH1381	B_{OPS} (South Pole to Part Marking Side)	Operating Point	T_A = +25°C	10	18	26	Gauss
			T_A = -40°C to +85°C	6	18	30	
	B_{RPS} (South Pole to Part Marking Side)	Releasing Point	T_A = +25°C	3	11	19	
			T_A = -40°C to +85°C	2	11	24	
	B_{HY} ($\|B_{OPS}\|$-$\|B_{RPS}\|$)	Hysteresis	(Note 10)	2	7	—	
AH1382	B_{OPS} (South Pole to Part Marking Side)	Operating Point	T_A = +25°C	22	30	38	Gauss
			T_A = -40°C to +85°C	18	30	42	
	B_{RPS} (South Pole to Part Marking Side)	Releasing Point	T_A = +25°C	12	20	30	
			T_A = -40°C to +85°C	8	20	33	
	B_{HY} ($\|B_{OPS}\|$-$\|B_{RPS}\|$)	Hysteresis	(Note 10)	2	10	—	
AH1383	B_{OPS} (South Pole to Part Marking Side)	Operating Point	T_A = +25°C	35	45	55	Gauss
			T_A = -40°C to +85°C	25	45	60	
	B_{RPS} (South Pole to Part Marking Side)	Releasing Point	T_A = +25°C	25	35	45	
			T_A = -40°C to +85°C	20	35	55	
	B_{HY} ($\|B_{OPS}\|$-$\|B_{RPS}\|$)	Hysteresis	(Note 10)	2	10	—	

Note: 10. Maximum and minimum parameters values over operating temperature range are not tested in production, they are guaranteed by design, characterization and process control. The magnetic characteristics may vary with supply voltage, operating temperature and after soldering.

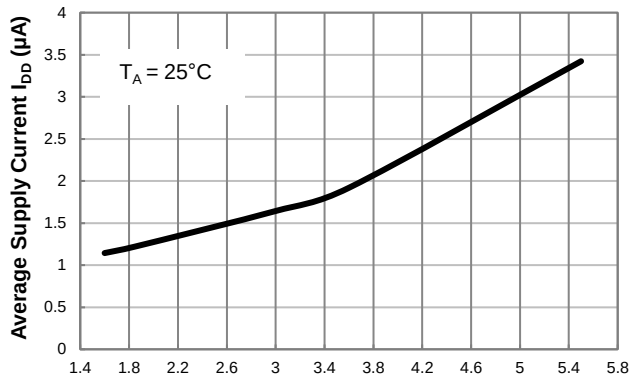




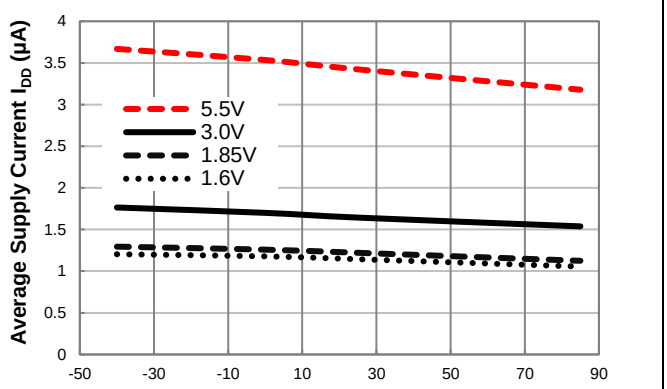
SOT23 (Type S) **X2-DFN1410-4**
X2-DFN1010-4 (Type B)

Typical Operating Characteristics

Average Supply Current $I_{DD(AVG)}$

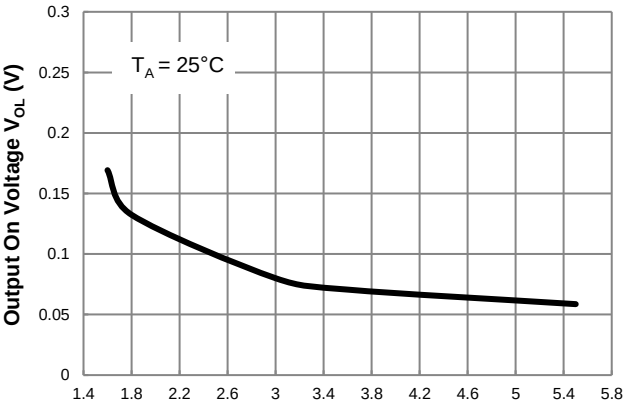


$I_{DD(AVG)}$ vs. Supply Voltage

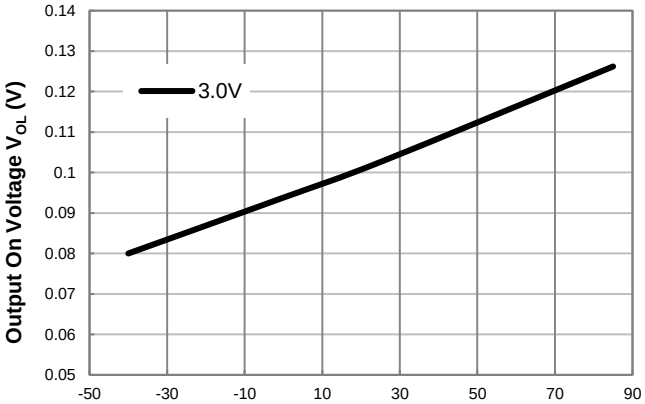


$I_{DD(AVG)}$ vs. Temperature

Output Low Voltage (On) V_{OL}, I_{OUT} = 1mA

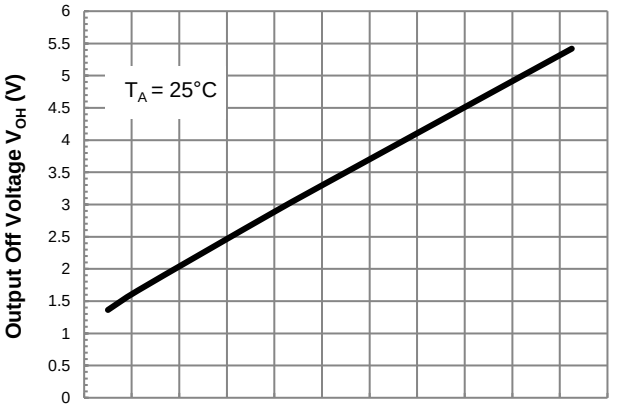


Output On Voltage vs. Supply Voltage

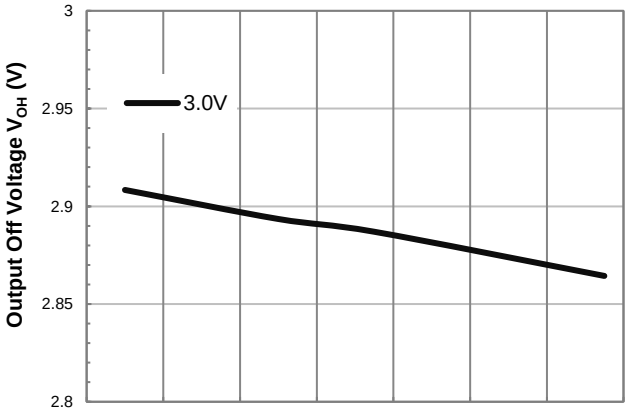


Output On Voltage vs. Temperature

Output High Voltage (Off) V_{OH}, I_{OUT} = -1mA



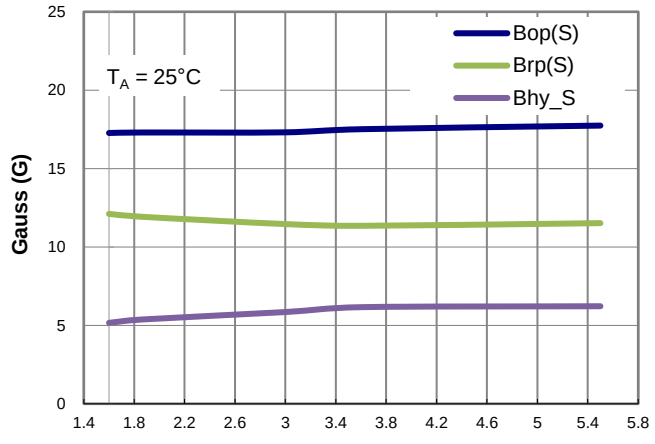
Output Off Voltage vs. Supply Voltage



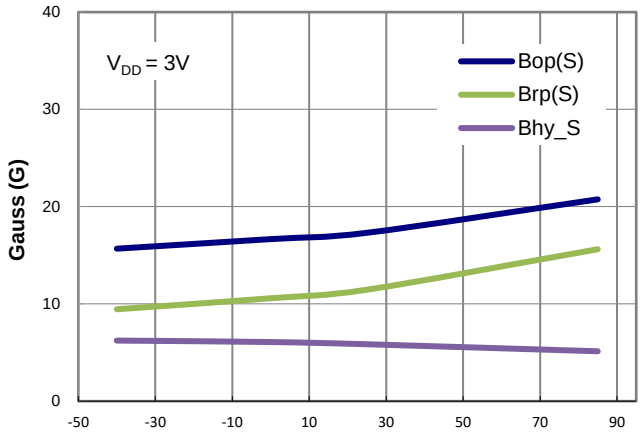
Output Off Voltage vs. Temperature

Typical Operating Characteristics (continued)

AH1381 – Switch Point B_{OP}/B_{RP} and Hysteresis B_{HY}

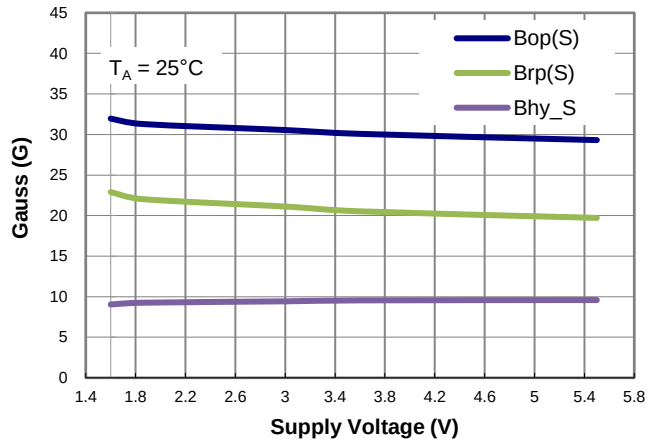


Switch Points vs. Supply Voltage

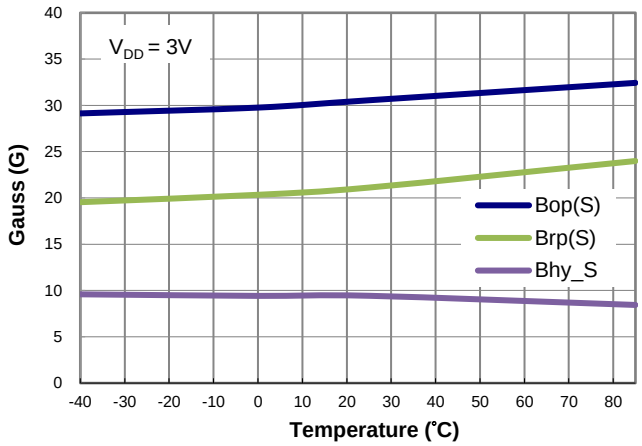


Switch Points vs. Temperature

AH1382 – Switch Point B_{OP}/B_{RP} and Hysteresis B_{HY}

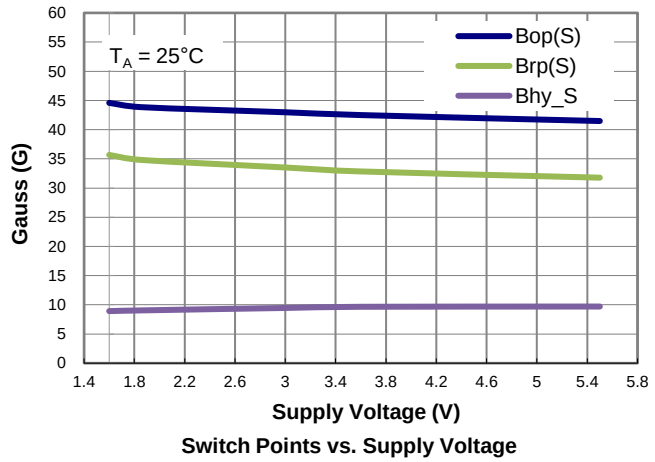


Switch Points vs. Supply Voltage

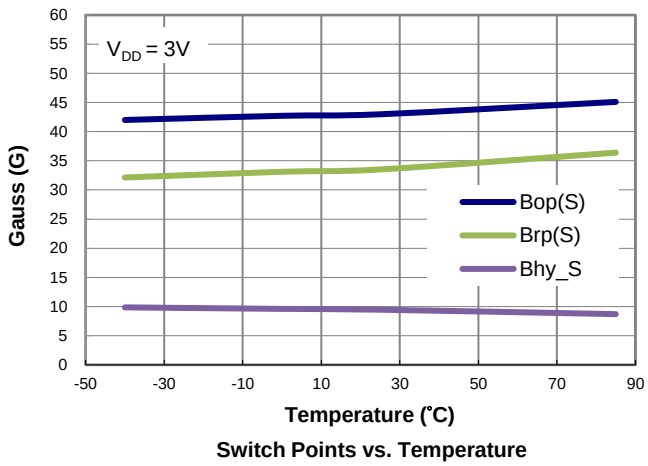


Switch Points vs. Temperature

AH1383 – Switch Point B_{OP}/B_{RP} and Hysteresis B_{HY}

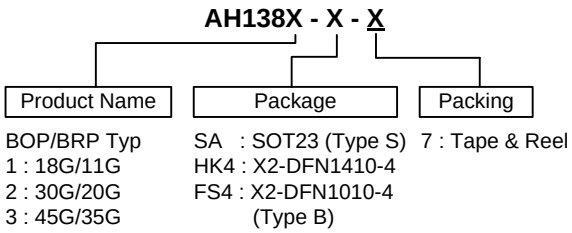


Switch Points vs. Supply Voltage



Switch Points vs. Temperature

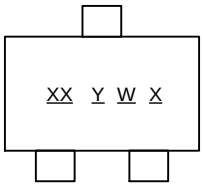
Ordering Information



Part Number	Part Number Suffix	Package Code	Package	Packing	
				Qty.	Carrier
AH138X-SA-7	-7	SA	SOT23 (Type S)	3000	7” Tape & Reel
AH138X-HK4-7	-7	HK4	X2-DFN1410-4	4000	7” Tape & Reel
AH138X-FS4-7	-7	FS4	X2-DFN1010-4 (Type B)	5000	7” Tape & Reel

Marking Information

(1) Package Type: SOT23 (Type S)

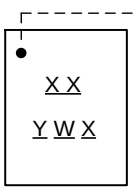


XX : Identification Code
Y : Year : 0 to 9 (ex: 3 = 2023)
W : Week : A to Z : Week 1 to 26;
a to z : Week 27 to 52; z Represents Week 52 and 53
X : Internal Code

Part Number	Package	Identification Code
AH1381-SA-7	SOT23 (Type S)	F6
AH1382-SA-7		F7
AH1383-SA-7		F8

(2) Package Type: X2-DFN1410-4

(Top View)



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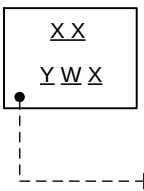
X : Internal Code

Part Number	Package	Identification Code
AH1381-HK4-7	X2-DFN1410-4	F6
AH1382-HK4-7		F7
AH1383-HK4-7		F8

(3) Package Type: X2-DFN1010-4 (Type B)

(Top View)



XX : Identification Code
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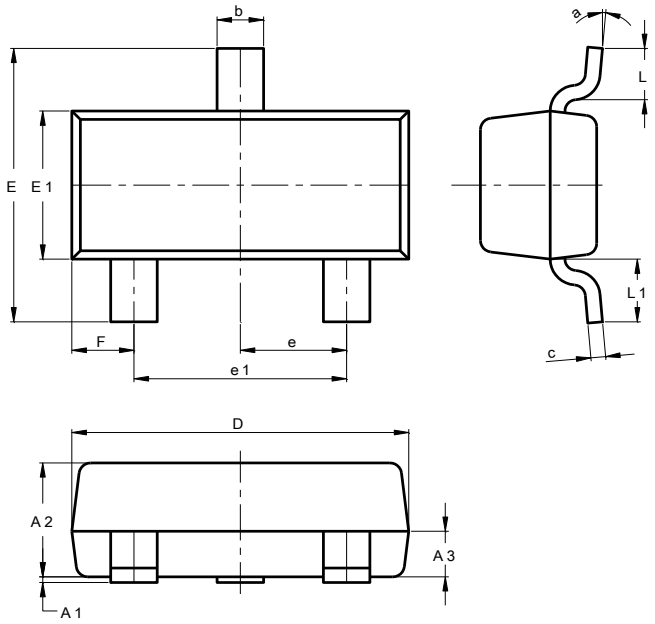
a to z : Week 27 to 52; z Represents Week 52 and 53
X : Internal Code

Part Number	Package	Identification Code
AH1381-FS4-7	X2-DFN1010-4 (Type B)	J6
AH1382-FS4-7		J7
AH1383-FS4-7		J8

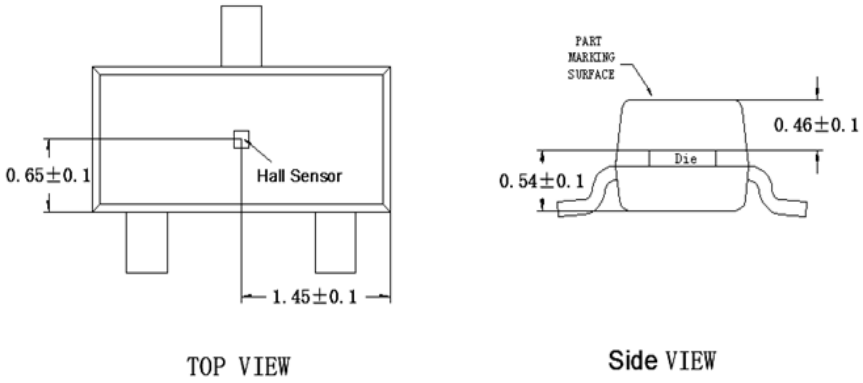
Package Outline Dimensions

Please see http://www.diodes.com/package-outlines.html for the latest version.

(1) Package Type: SOT23 (Type S)



SOT23 (Type S)			
Dim	**Min**	**Max**	**Typ**
A1	0.013	0.10	0.05
A2	0.90	1.025	1.00
A3	0.375	0.425	0.40
b	0.37	0.51	0.40
c	0.10	0.18	0.125
D	2.80	3.00	2.90
E	2.30	2.50	2.40
E1	1.20	1.40	1.30
e	0.89	1.03	0.915
e1	1.78	2.05	1.83
F	0.45	0.60	0.535
L1	0.45	0.61	0.55
L	0.25	0.55	0.40
a	0°	8°	--
All Dimensions in mm			

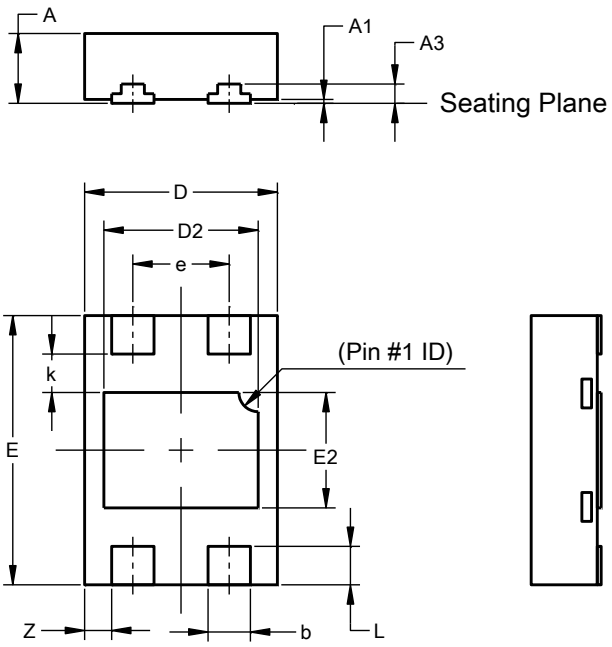


Sensor Location

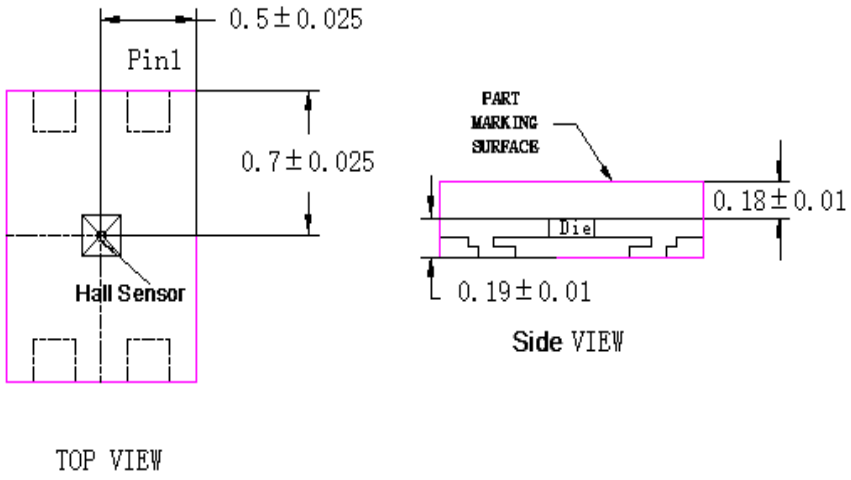
Package Outline Dimensions (continued)

Please see http://www.diodes.com/package-outlines.html for the latest version.

(2) Package Type: X2-DFN1410-4



X2-DFN1410-4			
Dim	**Min**	**Max**	**Typ**
A	--	0.40	0.37
A1	0.00	0.05	0.02
A3	--	--	0.100
b	0.17	0.27	0.22
D	0.95	1.05	1.00
D2	0.70	0.90	0.80
E	1.35	1.45	1.40
E2	0.50	0.70	0.60
e	0.50BSC		
k	--	--	0.20
L	0.15	0.25	0.20
z	--	--	0.14
All Dimensions in mm			

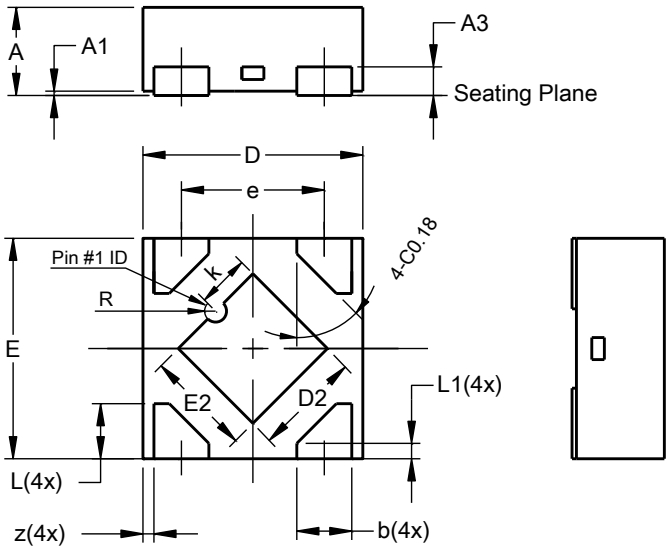


Sensor Location

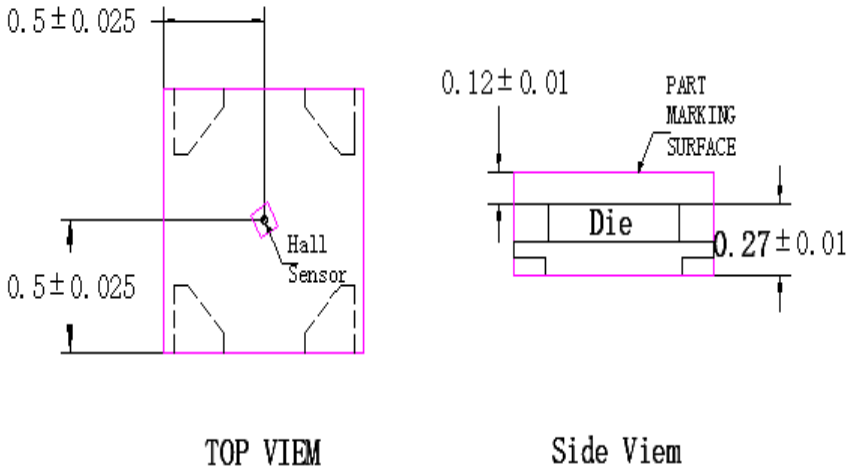
Package Outline Dimensions (continued)

Please see http://www.diodes.com/package-outlines.html for the latest version.

(3) Package Type: X2-DFN1010-4 (Type B)



X2-DFN1010-4 (Type B)			
Dim	**Min**	**Max**	**Typ**
A	-	0.40	0.39
A1	0.00	0.05	0.02
A3	-	-	0.13
b	0.20	0.30	0.25
D	0.95	1.05	1.00
D2	0.43	0.53	0.48
E	0.95	1.05	1.00
E2	0.43	0.53	0.48
e	-	-	0.65
k	0.19	0.29	0.24
L	0.20	0.30	0.25
L1	0.02	0.12	0.07
R	0.02	0.08	0.05
z	-	-	0.050
All Dimensions in mm			

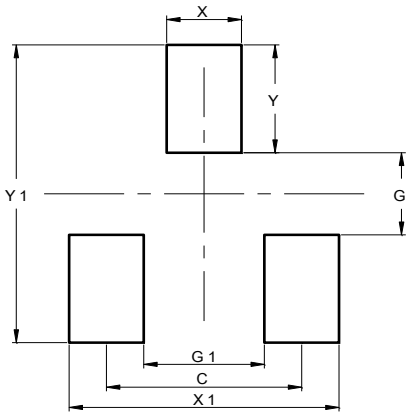


Sensor Location

Suggested Pad Layout

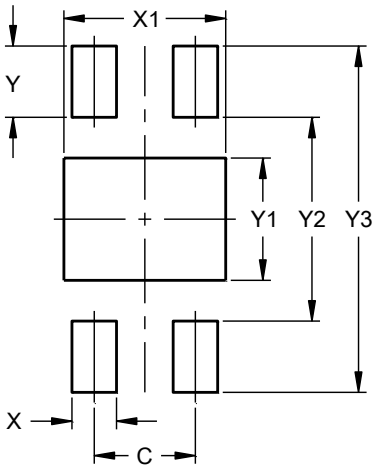
Please see http://www.diodes.com/package-outlines.html for the latest version.

(1) Package Type: SOT23 (Type S)



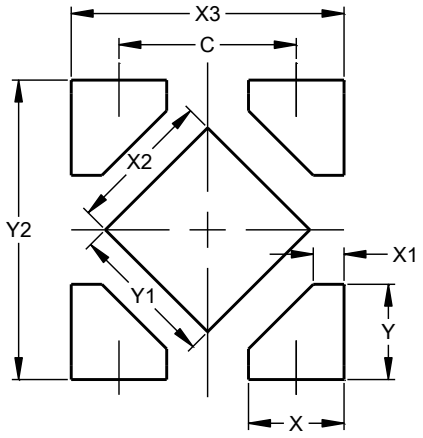
Dimensions	Value (in mm)
C	1.830
G	0.800
G1	1.130
X	0.700
X1	2.530
Y	1.050
Y1	2.900

(2) Package Type: X2-DFN1410-4



Dimensions	Value (in mm)
C	0.50
X	0.22
X1	0.80
Y	0.35
Y1	0.60
Y2	1.00
Y3	1.70

(3) Package Type: X2-DFN1010-4 (Type B)



Dimensions	Value (in mm)
C	0.650
X	0.350
X1	0.112
X2	0.530
X3	1.00
Y	0.350
Y1	0.530
Y2	1.100

Mechanical Data

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 (e3)
- Weight: 0.008 grams (Approximate)

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