MT896X

Latch, Hall-Effect Switch IC with Self-diagnosis

1 Product Description

The MT896X family is a hall-effect switch IC with self diagnosis produced by BCD technology with both high performance and high reliability. The Hall IC internally includes an on-chip Hall voltage generator, a voltage regulator for operation with supply voltage of 2.7V to 24V, temperature compensation circuitry, small-signal amplifier, Hall IC with dynamic offset cancellation system, Schmitt trigger and open drain output, all in a single package.

The MT896X family offers self-diagnosis function during the sensor power-on. This allows the user to check the functionality of the whole signal path in response to BOP and BRP, as well as the wire connections of the sensor IC.

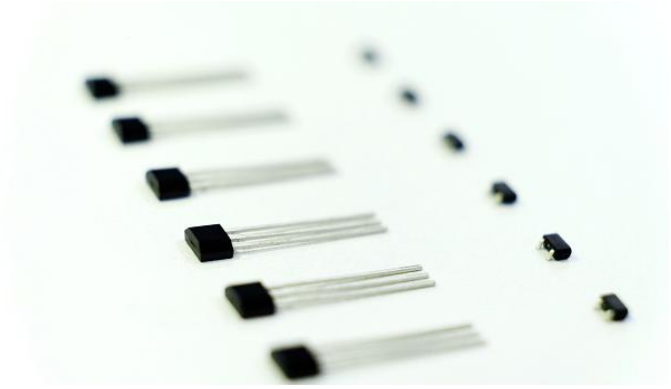
The MT896X family provides SOT-23 & SOT-23 (Thin Outline) for surface mount and TO-92 for through-hole to customers. All packages are RoHS compliant.

2 Features

- AEC-Q100 Automotive Qualified
- 2.7~24V Operating V_{DD} Range
- -40℃~150℃ Operating Temperature
- Package Option:
  SOT-23
  SOT-23 (Thin Outline)
  TO-92
- Magnetic Sensitivity Option:
  MT8962 (B_{OP}=25Gs, B_{RP}=-25Gs)
- Self-diagnosis
- -30V Reversed Power Supply Protection
- Output Over Current Protection
- RoHS Compliant: (EU)2015/863
- ASIL-B ready

3 Product Overview of MT896X

Part No.	Description
MT896XAT	SOT-23, tape & reel (3000pcs/bag)
MT896XET	SOT-23 (Thin Outline), tape & reel (3000pcs/bag)
MT896XA	Flat TO-92, bulk packaging (1000pcs/bag)



4 Applications

- Automotive, Home appliances,
- Industrial
- Speed Detection
- Magnetic Encoder
- Brushless DC Motor Communication

5 Pin Configuration and Functions

	Vcc	Out	GND
SOT-23	1	2	3
SOT-23 (Thin Outline)	1	2	3
Flat TO-92	1	3	2
Description	Power	Output Open-Drain	Ground

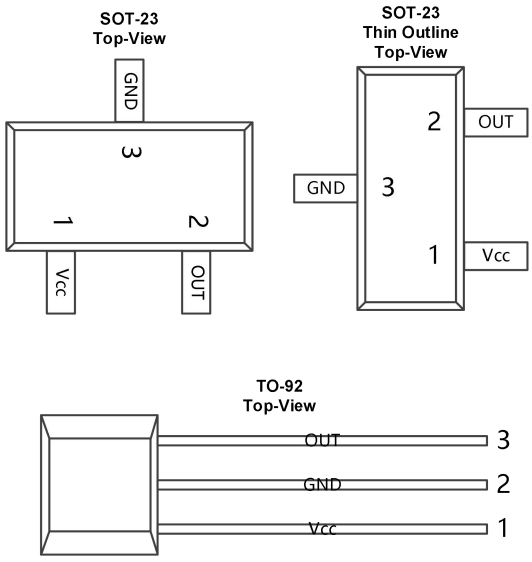


Figure.1 Pin Configuration & Functions

Table of Contents

Reversion History

1	Version 1.0	Original Version
2	Version 1.1	Update Package Material Information

6 Switching Function

6.1 Definition of Switching Function

Figure.2 and Figure.3 show the device functionality and hysteresis

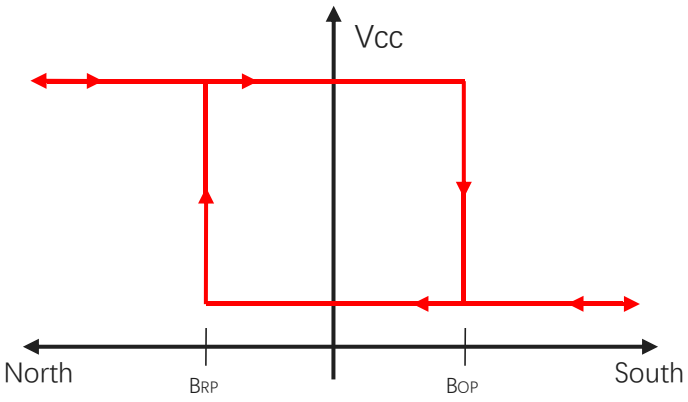


Figure.2 Switching Function of FlatTO-92 & SOT-23 (Thin Outline)

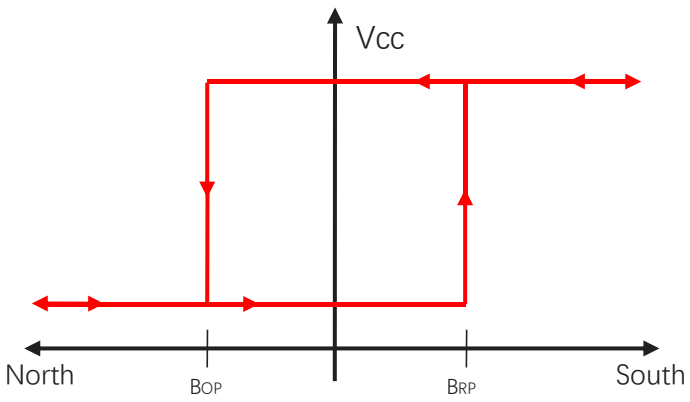


Figure.3 Switching Function of SOT-23

6.2 Function Description

B_{OP}: Operating Point, Magnetic flux density applied on the branded side of the package which turns the output driver ON (V_{OUT}=Low)

B_{RP}: Releasing Point, Magnetic flux density applied on the branded side of the package which turns the output driver OFF (V_{OUT}=High)

B_{HYST}: Hysteresis Window, $|B_{OP} - B_{RP}|$
Devices that have a lower magnetic threshold (V_{OUT}=High) detect magnets at a farther distance. Higher thresholds (V_{OUT}=Low) generally require a closer distance or larger magnet.

6.3 Feature Description

The MT896X device is sensitive to the magnetic field component that is perpendicular to the top of the package

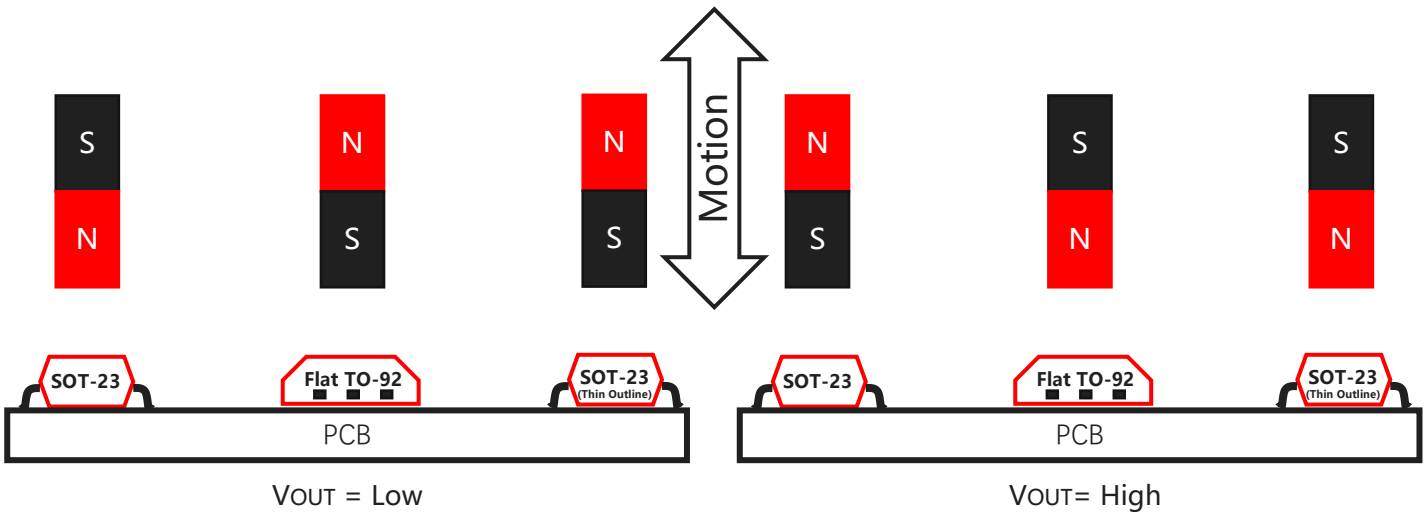


Figure.4 Flux Direction Polarity

7 Functional Block Diagram

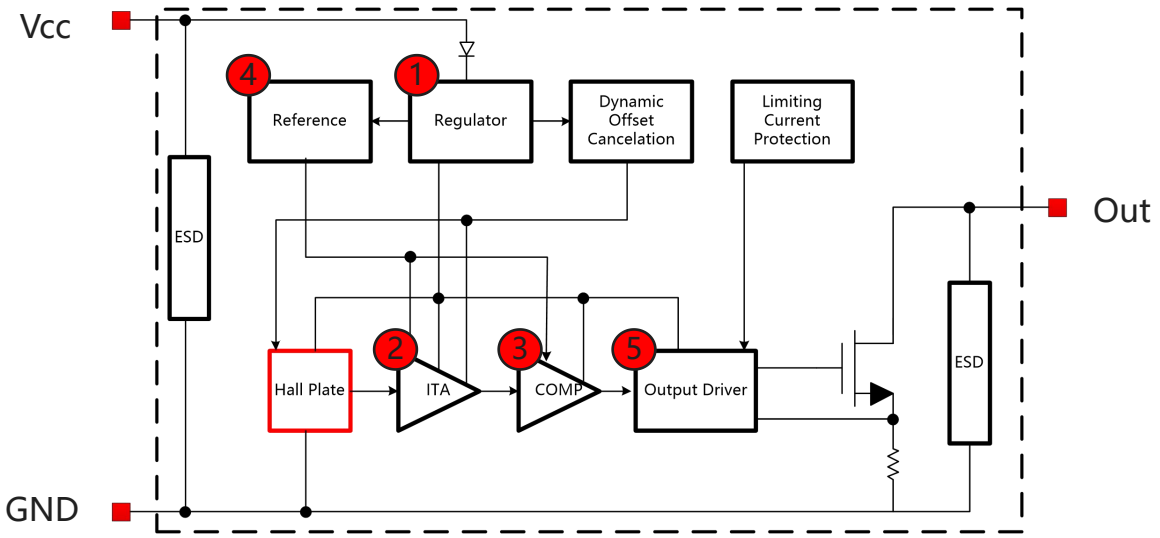


Figure.5 Functional Block Diagram

7.1 Diagnostics Coverage Block Diagram

No	Feature	Definition
1	Regulator	Regulator voltage for normal operation
2	AMP	Signal Amplifier
3	COMP	Comparator
4	Reference	Reference
5	Open Drain Output	Output

8 Electrical and Magnetic Characteristics

8.1 Absolute Maximum Ratings

Absolute maximum ratings are limited values to be applied individually, and beyond which the serviceability of the circuit may be impaired. Functional operability is not necessarily implied. Exposure to absolute maximum rating conditions for an extended period of time may affect device reliability.

Symbol	Parameters	Min	Max	Units
V_{DD}	Supply Voltage	-	30	V
V_{RDD}	Reverse Battery Voltage	-30	-	V
V_{OUT}	Output Voltage	-0.7	30	V
I_{OUT}	Continuous Output Current	-	40	mA
T_A	Operating Ambient Temperature	-40	150	℃
T_S	Storage Temperature	-50	150	℃
T_J	Junction Temperature	-	165	℃
B	Magnetic Flux Density	No Limit		Gs

8.2 Electrical Specifications

At T_A=-40~150 ℃, V_{DD}=2.7V~24V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
V_{DD}	Supply Voltage	Operating	2.7	-	24	V
I_{DD}	Supply Current	F_S=100KHz	-	4.5	7.5	mA
I_{OCP}	Short Circuit Protection Current	B>B_{OP}, V_{OUT}=V_{DD}	-	30	-	mA
V_{DSON}	Output Saturation Voltage	I_{OUT}=10mA, B>B_{OP}	-	-	0.4	V
I_{OFF}	Output Leakage Current	V_{OUT}=24V, |B|<|BRP|	-	-	10	uA
T_R & T_F	Output Rise & Fall Time	R_L=1KOhm, C_L=20pF	-	-	1.0	us
T_{PO}(1)	Power on Time	dV_{DD}/dt>5V/uS B>$B_{OP(MAX)}$	-	20	30	us
F_S	Sampling Frequency		-	100	-	KHz
R_{TH}	Thermal Resistance of SOT-23 & SOT-23 (Thin Outline)		-	301	-	℃/W
	Thermal Resistance of Flat TO-92		-	230	-	℃/W

Notes:
(1) TPO here is defined when self-diagnosis is disabled. If self-diagnosis is enabled, please refer to the t_{edge3} in Part 9 (Self-diagnosis)

8.3 Typical Output Waveform

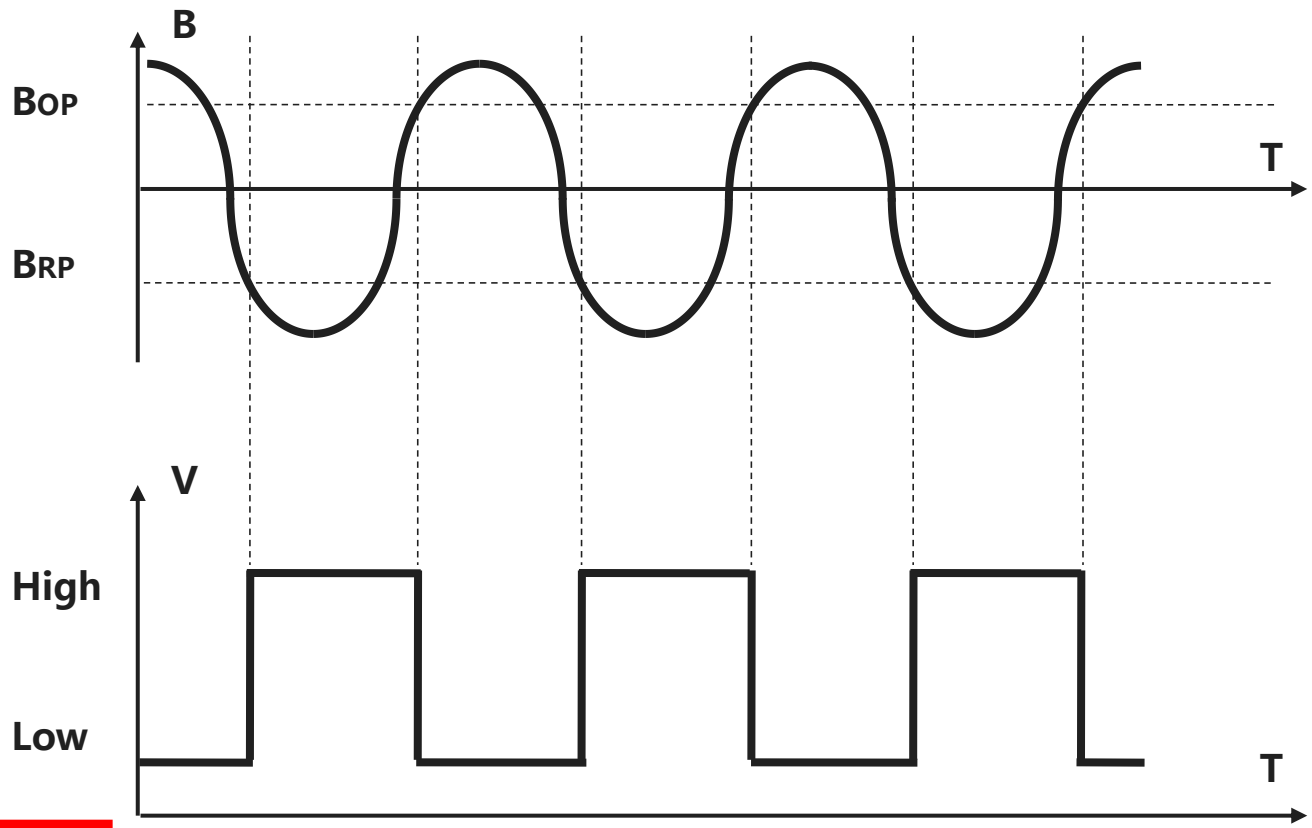


Figure.6 Digital Output vs. Magnetic Flux Density (MT8962A as example)

8.4 Magnetic Characteristics

At V_{DD}=2.7V~24V (unless otherwise specified)

Part No.	Symbol	Min	Typ	Max	Unit
MT8962 Series	BOP, TA =25℃	10	25	40	Gs
	BRP, TA =25℃	-40	-25	-10	Gs
	BHYST, TA =25℃	20	50	80	Gs

8.5 ESD Ratings

Symbol		Reference	Values	Unit
VESD	Human-body model (HBM)	AEC-Q100-002	Class 3A	Grade
	Charged-device model (CDM)	AEC-Q100-011 Rev-D	Class C3	Grade

8.6 Characteristics Performance

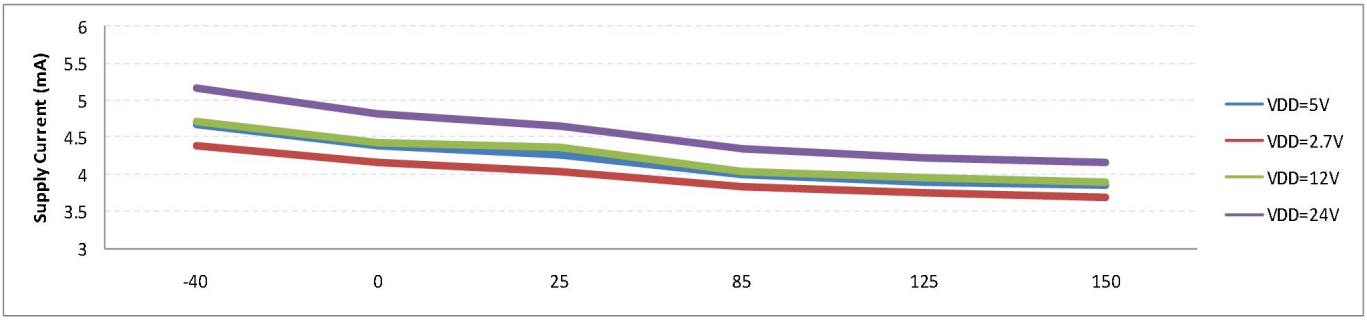


Figure.7 Supply Current vs. Temperature & VDD

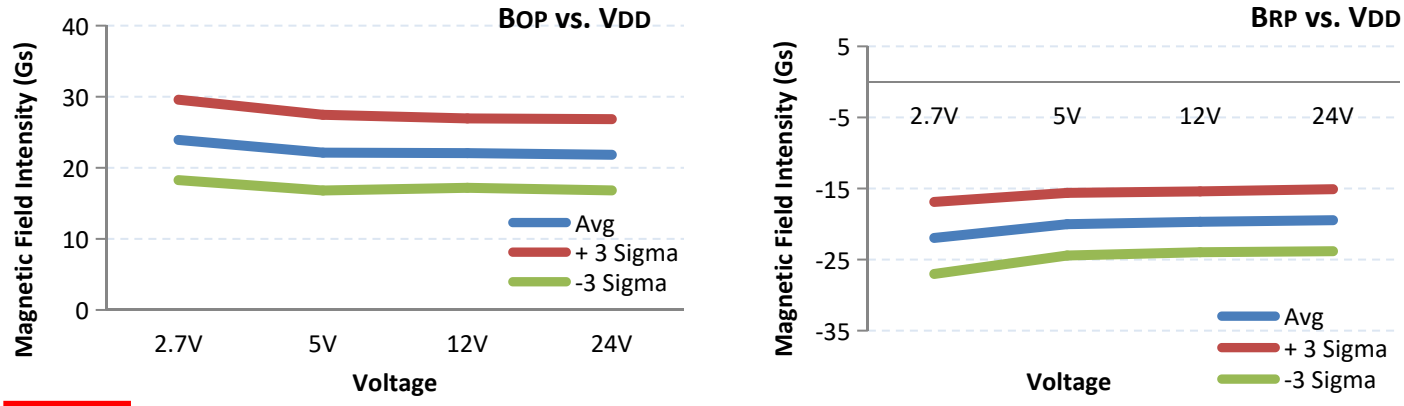


Figure.8 Magnetic Characteristics (BOP & BRP) vs. VDD @ Temperature=25℃

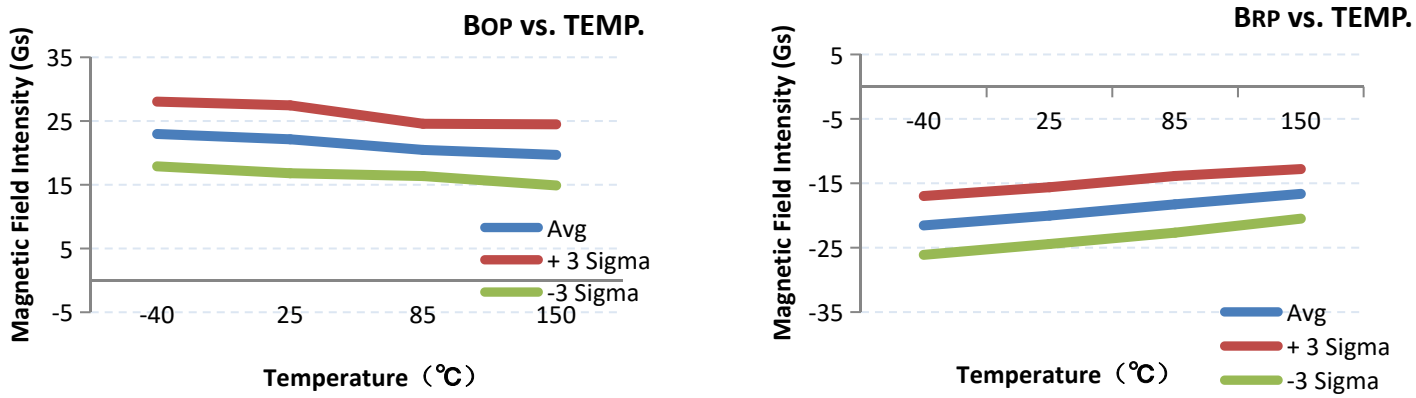


Figure.9 Magnetic Characteristics (BOP & BRP) vs. Temperature @ VDD =5V

9 Typical Application Circuit

Note: Recommended value for R_L is 5KOhms to 20KOhms

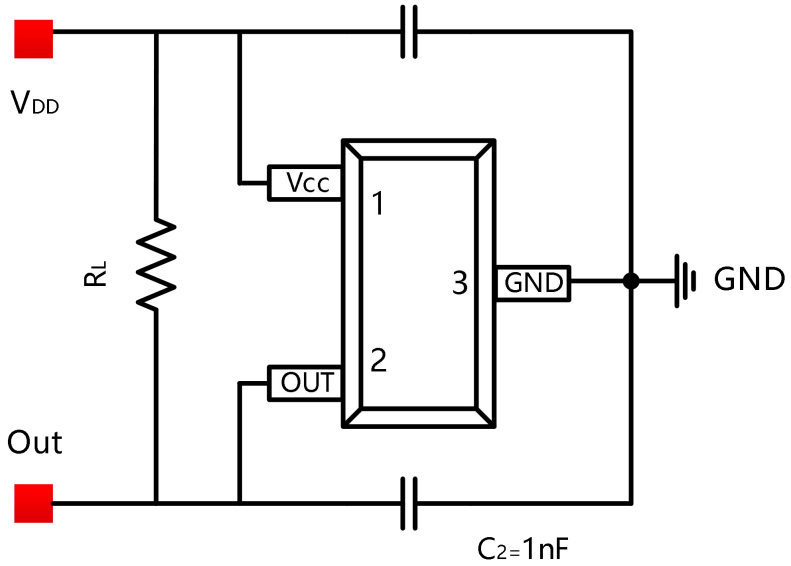


Figure.10 Typical Application Circuit (MT8962AT as example)

10 Self-diagnosis

The MT896X family offers self-diagnosis function during the sensor power-on. This allows the user to check the functionality of the whole signal path in response to BOP and BRP, as well as the wire connections of the sensor IC.

In order to activate the self-diagnosis function, user are advised to connect their system as shown in Figure.11, in which a host is required to control the VDD and Out port of the sensor. Then user should follow the following two steps:

Firstly the host has to power off the sensor and the host I/O pull the sensor output low.

Then the host powers on the sensor, and the host I/O has to release the Out afterwards. Referring to the self-diagnosis timing diagram in Figure.12, there is a minimum time interval between t_{sup} (the moment when VSUP has reached 90% of its final value) and t_{rls} (the moment when host I/O releases).

If any one of the 2 criteria above is violated, the sensor might skip the self-diagnosis phase and enter the normal operation mode.

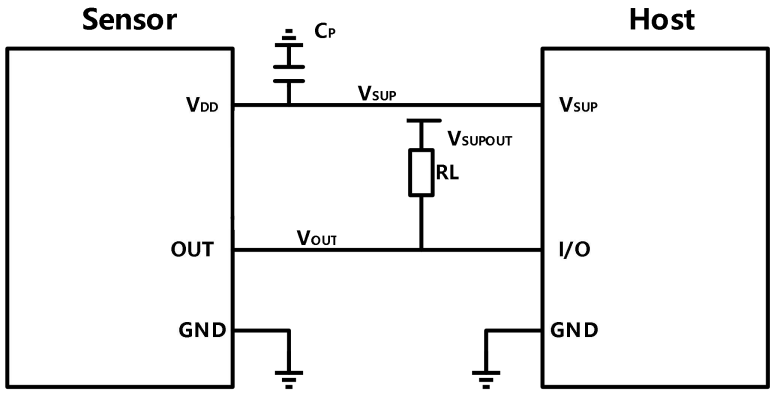


Figure.11 Sensor-Host connection diagram for self-diagnosis function

10 Self-diagnosis (Continued)

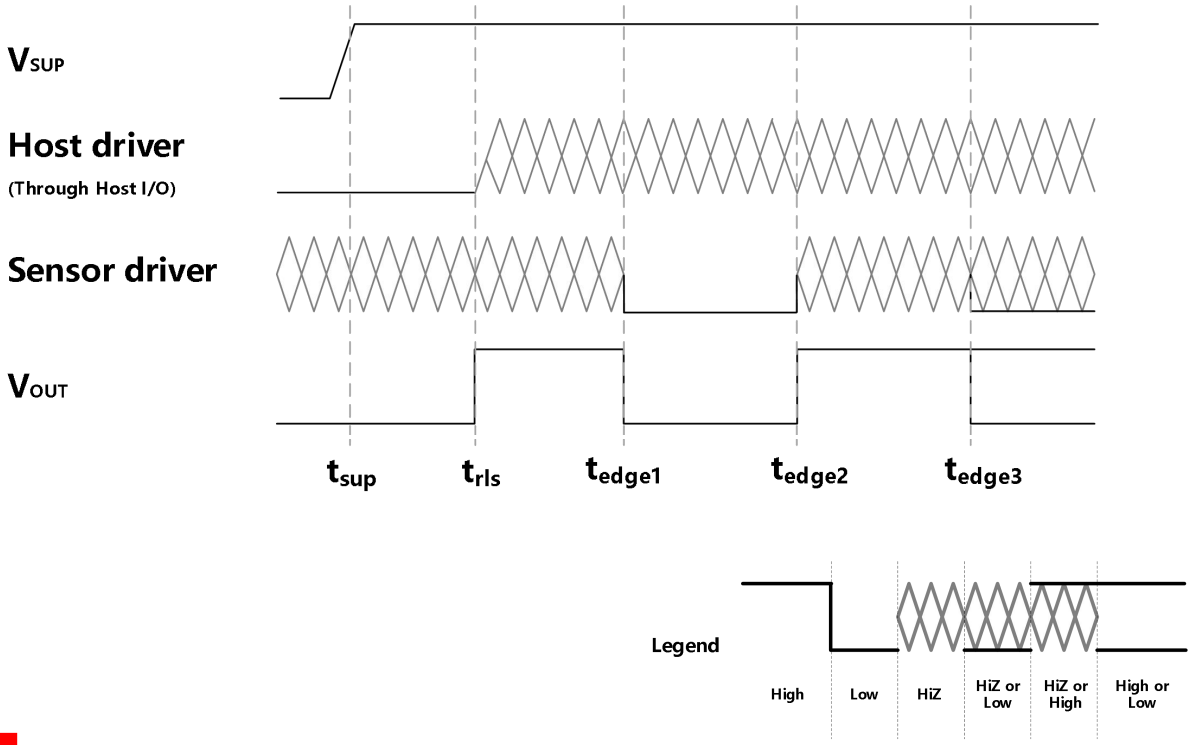


Figure.12 Self-diagnosis timing diagram

If the self-diagnosis function is activated, firstly the VOUT will be pulled high by RL since host I/O has released. Then the sensor will generate a first dummy signal that drives the output low, which simulates an BOP. The falling edge (t_{edge1}) of VOUT will be captured by the host. Afterwards the sensor generates a second dummy signal of the opposite polarity that drives the output high (by RL), which simulates an BRP. The rising edge (t_{edge2}) of VOUT is also captured by the host. Now the self-diagnosis phase has ended and then the sensor will enter its normal operation mode, sending the first real data to VOUT at t_{edge3}.

The two captured edges (t_{edge1} and t_{edge2}) should fall in a certain time window, specified in the table "Spec for self-diagnosis". This could be a criterion for host to determine whether or not the self-diagnosis has succeeded.

Spec for self-diagnosis

Symbol	Parameters	Min	Typ	Max	Unit
t_{rls}	Host I/O release time	t_{sup}+20(1)(2)	-	-	us
t_{edge1}	First falling edge of V_{OUT} during self-diagnosis	t_{rls}+5	t_{rls}+10	t_{rls}+15	us
t_{edge2}	First rising edge of V_{OUT} during self-diagnosis	t_{edge1}+5	t_{edge1}+10	t_{edge1}+15	us
t_{edge3}	First data available during normal operation	t_{rls}+15	t_{rls}+30	T_{rls}+45	us
B_{detmax}	Maximum external field allowed during self-diagnosis	-	5000	-	Gauss

Notes:
(1) t_{sup} is the time when sensor V_{DD} has reached 90% of its final value. V_{DD}=V_{SUP}.
(2) Power-on of V_{DD} has to be faster than 5V/us.

11 Package Material Information (For Reference Only – Not for Tooling Use)

11.1 SOT-23 Package Information

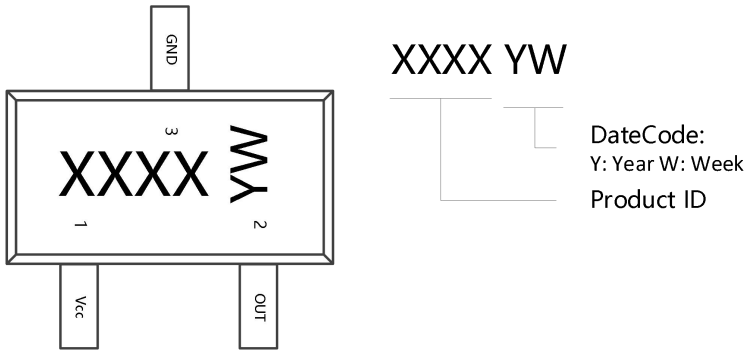


Figure.13 SOT-23 Chip Marking Spec

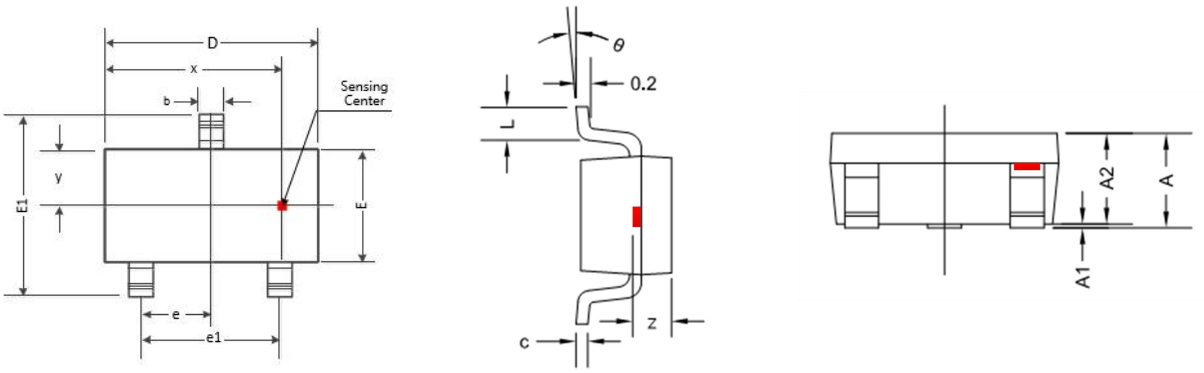


Figure.14 SOT-23 Package Drawing

Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.050	1.300	0.041	0.051
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.300	0.500	0.012	0.020
c	0.080	0.220	0.003	0.009
D	2.800	3.020	0.110	0.119
E	1.500	1.700	0.059	0.067
E1	2.600	3.000	0.102	0.118
e	0.950 TYP		0.037 TYP	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0 °	8 °	0 °	8 °
x	2.185 TYP		0.086 TYP	
y	0.756 TYP		0.030 TYP	
z	0.857 TYP		0.034 TYP	

11.2 SOT-23 (Thin Outline) Package Information

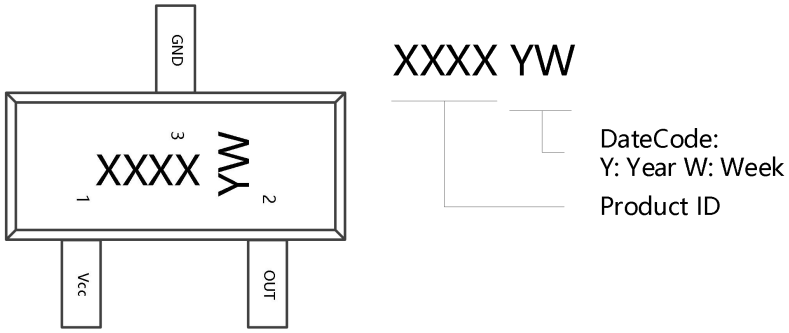


Figure.15 SOT-23 (Thin Outline) Chip Marking Spec

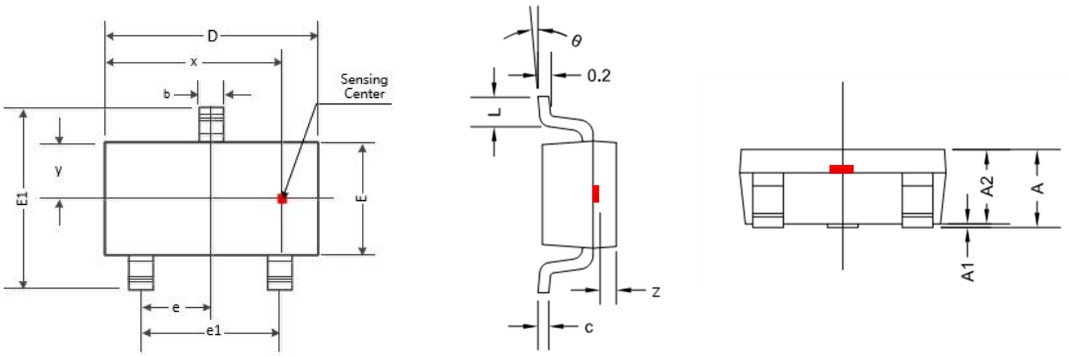


Figure.16 SOT-23 (Thin Outline) Package Drawing

Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	0.900	1.150	0.035	0.045
A1	0.000	0.100	0.000	0.004
A2	0.900	1.100	0.035	0.043
b	0.300	0.500	0.012	0.020
c	0.132	0.202	0.005	0.008
D	2.800	3.000	0.110	0.118
E	1.200	1.400	0.047	0.055
E1	2.250	2.550	0.089	0.100
e		0.950 TYP		0.037 TYP
e1	1.800	2.000	0.071	0.079
L		0.550 REF		0.022 REF
L1	0.300	0.500	0.012	0.020
θ	0 °	8 °	0 °	8 °
x		2.175 TYP		0.086 TYP
y		0.596 TYP		0.023 TYP
z		0.193 TYP		0.008 TYP

11.3 Flat TO-92 Package Information

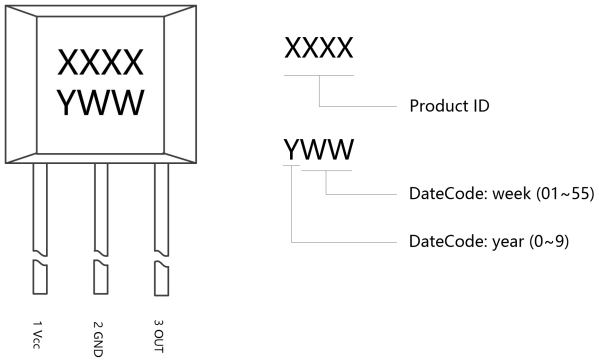


Figure.17 Flat TO-92 Chip Marking Spec

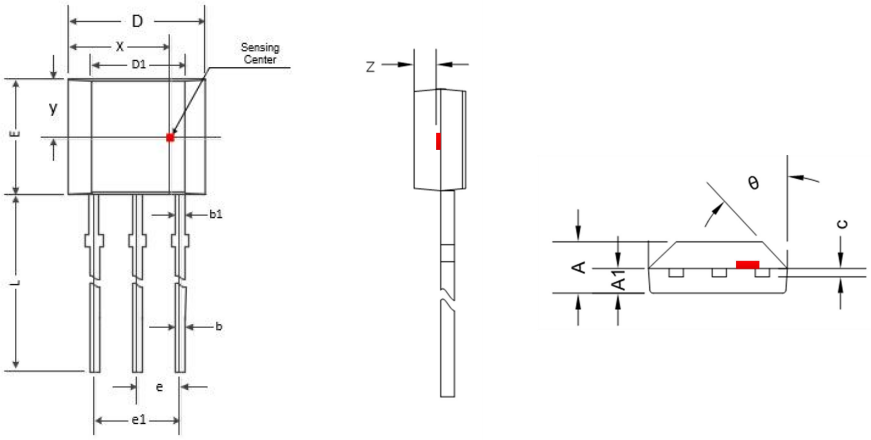


Figure.18 Flat TO-92 Package Drawing

Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.420	1.620	0.056	0.064
A1	0.660	0.910	0.026	0.036
b	0.330	0.560	0.013	0.022
b1	0.400	0.510	0.016	0.020
c	0.330	0.510	0.013	0.020
D	3.900	4.200	0.154	0.165
D1	2.280	2.680	0.090	0.106
E	2.900	3.280	0.114	0.128
e	1.270 TYP		0.050 TYP	
e1	2.440	2.640	0.096	0.104
L	13.500	16.200	0.531	0.638
θ	45 ° TYP		45 ° TYP	
x	2.000 TYP		0.079 TYP	
y	0.780 TYP		0.031 TYP	
z	0.435 TYP		0.017 TYP	

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