MT890X

AEC Qualified

MagnTek | Now Part of NOVOSENSE

Dual Hall Effect Latch with Speed & Direction Output

1 Product Description

The MT890X family is a Hall-effect dual latch 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 two open drain output, all in a single package.

Two Hall plates are integrated on the same chip, and using the high precision of the wafer fabrication process to ensure a fixed spacing of 1.45mm between the sensing elements. The first Hall plate provide the speed signal output. The combination of both the Hall plate signals is then internally processed to directly deliver a direction signal output.

The MT890X family provides SOT-23-6L for surface mount to customers & flat TO-94 for through-hole mount. All packages are RoHS compliant.

2 Features

- AEC-Q100 Automotive Qualified
  MT890XAT-SD & MT890XAT-SS
- Two Integrated Hall Plates for Direction Detection
- 2.7~24V Operating V_{DD} Range
- -40℃~150℃ Operating Temperature
- Package Option:
  SOT-23-6L
  Flat TO-94
- Magnetic Sensitivity Option:
  MT8901 (B_{OP}=25Gs, B_{RP}=-25Gs)
  MT8902 (B_{OP}=25Gs, B_{RP}=-25Gs)
- Speed & Direction Open-Drain Output
  Dual Speed Open-Drain Output
- Self-diagnosis
- -30V Reversed Power Supply Protection
- Output Over Current Protection
- RoHS Compliant: (EU)2015/863

3 Product Overview of MT890X

Part No.	Description
MT890XAT-SS	SOT-23-6L, tape & reel (3000pcs/bag)
MT890XAT-SD	SOT-23-6L, tape & reel (3000pcs/bag)
MT890XA-SS	Flat TO-94, bulk packaging (500pcs/bag)
MT890XA-SD	Flat TO-94, bulk packaging (500pcs/bag)

Note:



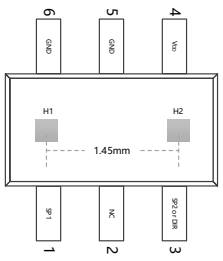
4 Applications

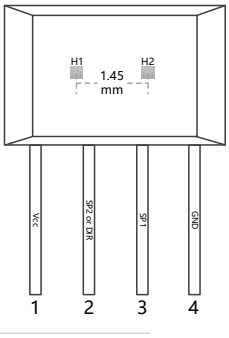
- Windows Lifter with Anti-Pinch Feature
- Rotation Speed & Direction Detection
- Linear Speed & Direction Detection

5 Pin Configuration and Functions

SOT-23-6L	No.	Description
SP1	1	Speed Signal Out1
NC	2	Unconnected
SP2 or DIR	3	Speed Signal Out2 or Direction Signal Out
V_{DD}	4	Power Supply
GND	5	Ground
GND	6	Ground

Flat TO-94	No.	Description
V_{DD}	1	Power Supply
SP2 or DIR	2	Speed Signal Out2 or Direction Signal Out
SP1	3	Speed Signal Out1
GND	4	Ground





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Reversion History

1	Original Version	
2	Version 1.1	Update marking spec
3	Version 1.2	Update MT890XA Series Update the description of self-diagnosis
4	Version 1.3	Add characteristic performance
5	Version 1.4	Update AEC-Q100 Automotive of MT890XAT-SD & MT890XAT-SS
6	Version 1.5	Update MT8902 Series
7	Version 1.6	Update the packaging of MT890XA-SS & MT890XA-SD

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6 Functional Block Diagram

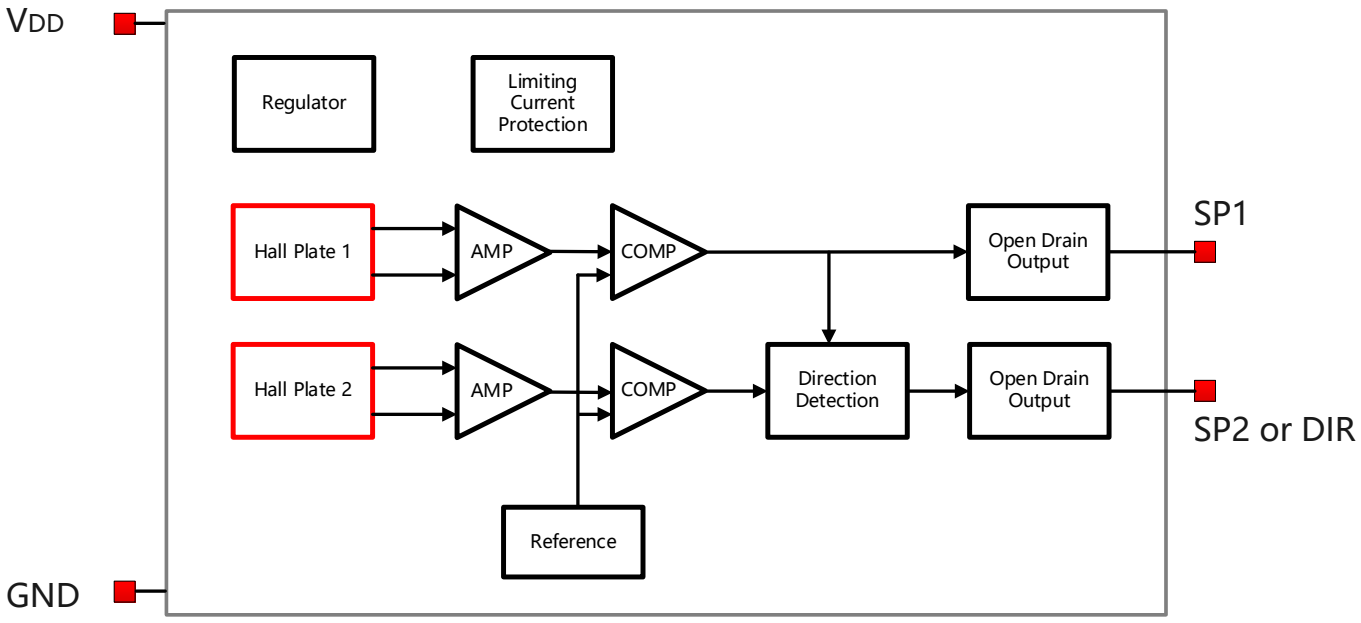


Figure.2 Functional Block Diagram

7 Electrical and Magnetic Characteristics

7.1 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	160	℃
T_J	Junction Temperature	-	165	℃
B	Magnetic Flux Density	No Limit		Gs

7.2 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
T_D	Delay Time Refer to Figure.9&10		-	1.2	2.5	us
R_{TH}	Thermal Resistance of SOT-23-6L		-	301	-	℃/W
	Thermal Resistance of Flat TO-94			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 11 (Self-diagnosis)

7.3 ESD Ratings

Symbol		Reference	Values	Unit
V_{ESD}	Human-body model (HBM)	AEC-Q100-002	Class H3	Grade
	Charged-device model (CDM)	AEC-Q100-011	Class C3	Grade

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7.4 Magnetic Characteristics

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

7.4.1 MT890X Series

Parameter	Symbol	Min	Typ	Max	Unit
Operating Point	B_{OP}, T_A =25℃	10	25	40	Gs
Release Point	B_{RP}, T_A =25℃	-40	-25	-10	Gs
Hysteresis Window	B_{HYST}, T_A =25℃	20	50	80	Gs
Magnetic Matching	B_{OP1}-B_{OP2} or B_{RP1}-B_{RP2}, T_A=25℃	-10		10	Gs
Magnetic Offset	B_{OP1}+B_{RP1} or B_{OP2}+B_{RP2}, T_A=25℃	-10		10	Gs
Temperature Coefficient			-1000		ppm/℃
Hall Sensor Spacing			1.45		mm

7.5 Characteristic Performance

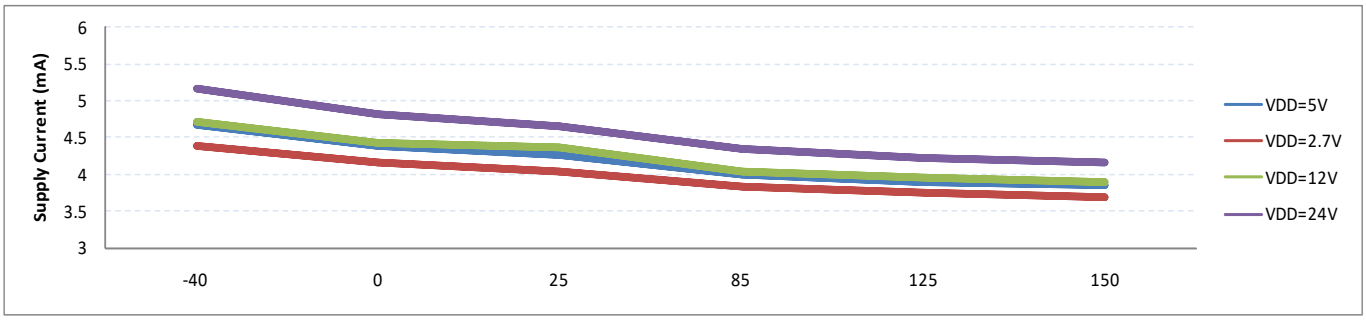


Figure.3 Supply Current vs. Temperature & V_{DD}

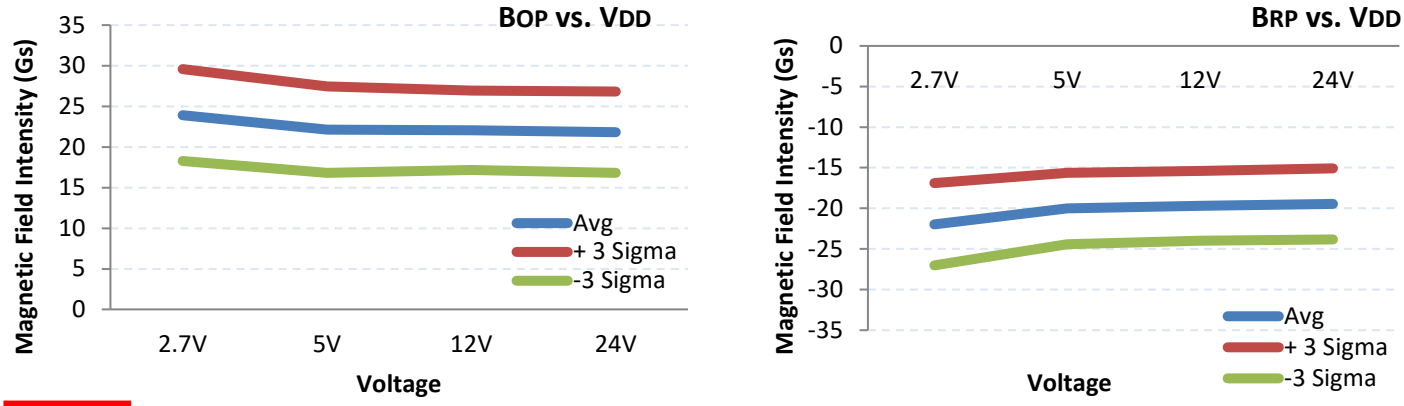


Figure.4 Magnetic Characteristics (B_{OP} & B_{RP}) vs. V_{DD} @ Temperature=25℃

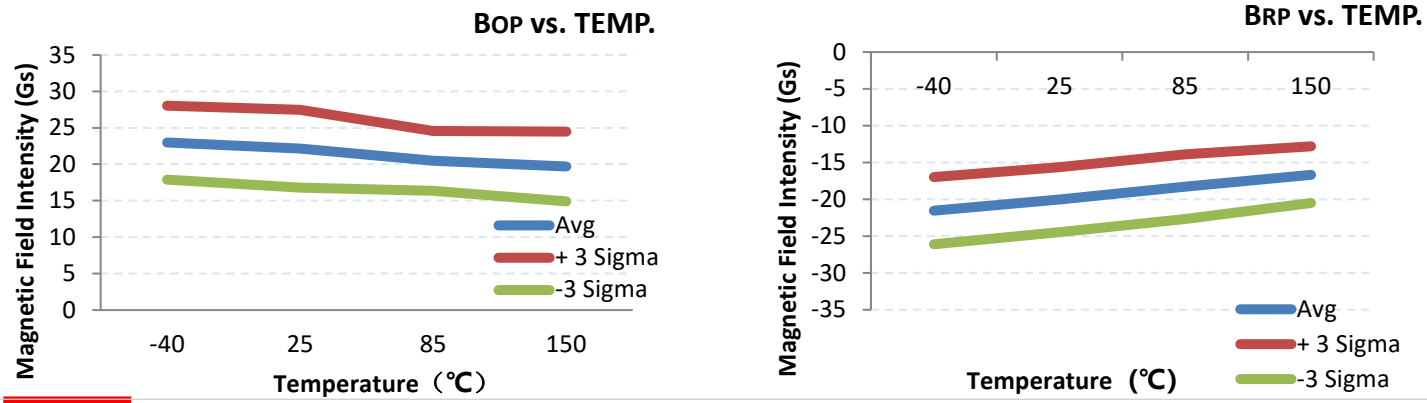


Figure.5 Magnetic Characteristics (B_{OP} & B_{RP}) vs. Temperature @ V_{DD} =5V

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8 Output Behavior vs. Magnetic Pole (SP1 + SP2 Mode)

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

Part No.	Parameter	Test Conditions	SP Output State
SOT-23 Series	South Pole	B>BOP	Low
	North Pole	B<BRP	High
TO-94 Series	North Pole	B>BOP	Low
	South Pole	B<BRP	High

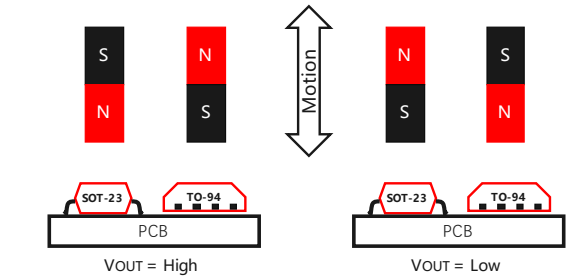
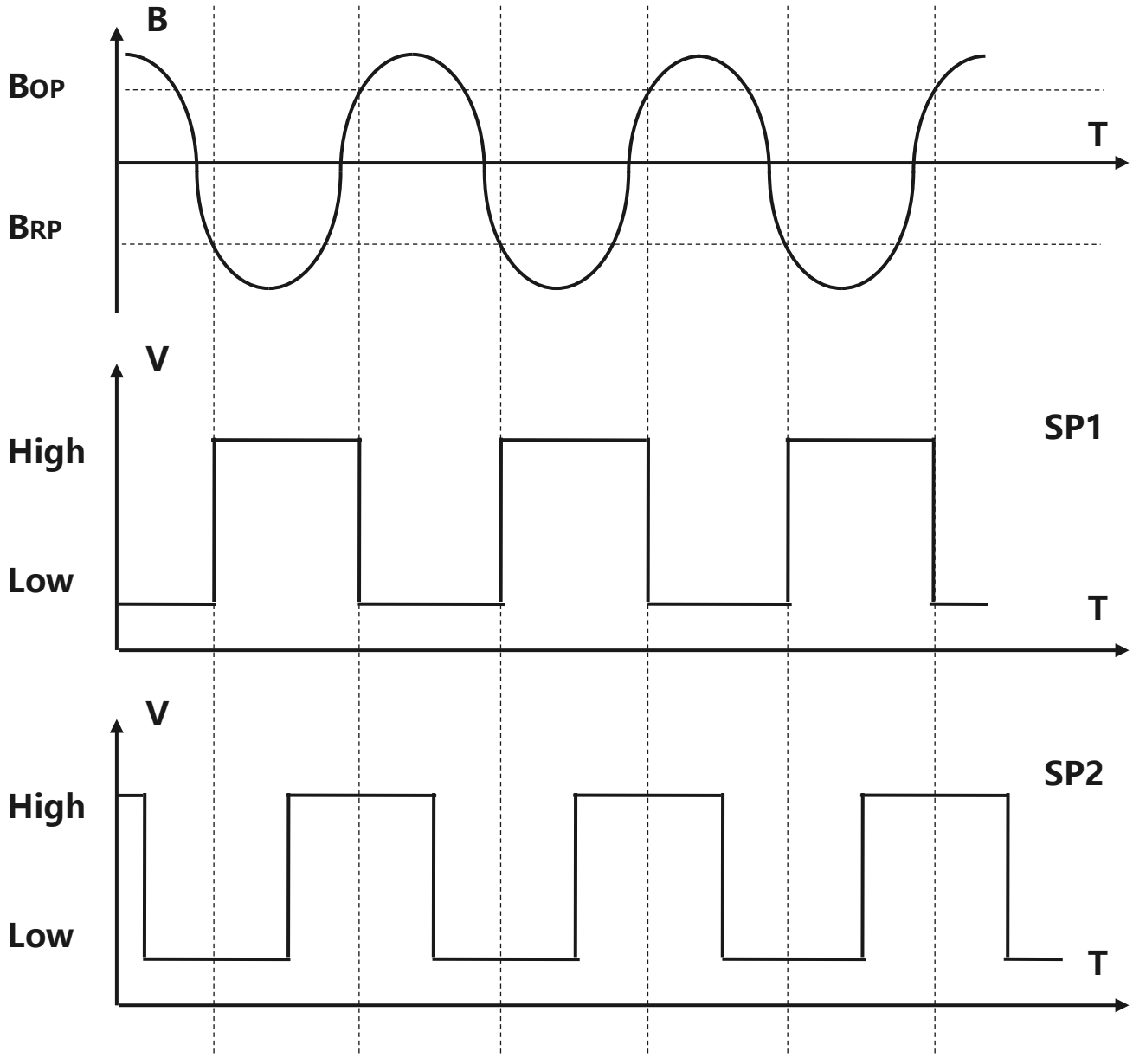


Figure.6

8.1 Typical Output Waveform (SP1 + SP2 Mode)

MT890XAT-SS as example



Note:
The phase error between Speed 1 & Speed 2 depends on the environment of the application

Figure.7

9 Output Behavior vs. Magnetic Pole (SP1 + DIR Mode)

At T_A=-40~150 ℃, V_{DD}=2.7V~24V (unless otherwise specified), MT890XAT-SD as example

Parameter	Test Conditions	H1	H2	SP Output State
CCW	nX	N	S	Low
	n(X+1)	N	N	
	n(X+2)	S	N	
	n(X+3)	S	S	
	n(X+4) ≡nX	N	S	

Parameter	Test Conditions	H1	H2	SP Output State
CW	nX	N	S	High
	n(X+1)	S	S	
	n(X+2)	S	N	
	n(X+3)	N	N	
	n(X+4) ≡nX	N	S	

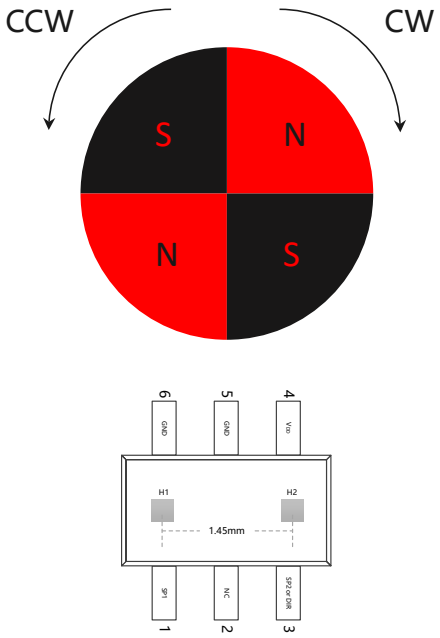
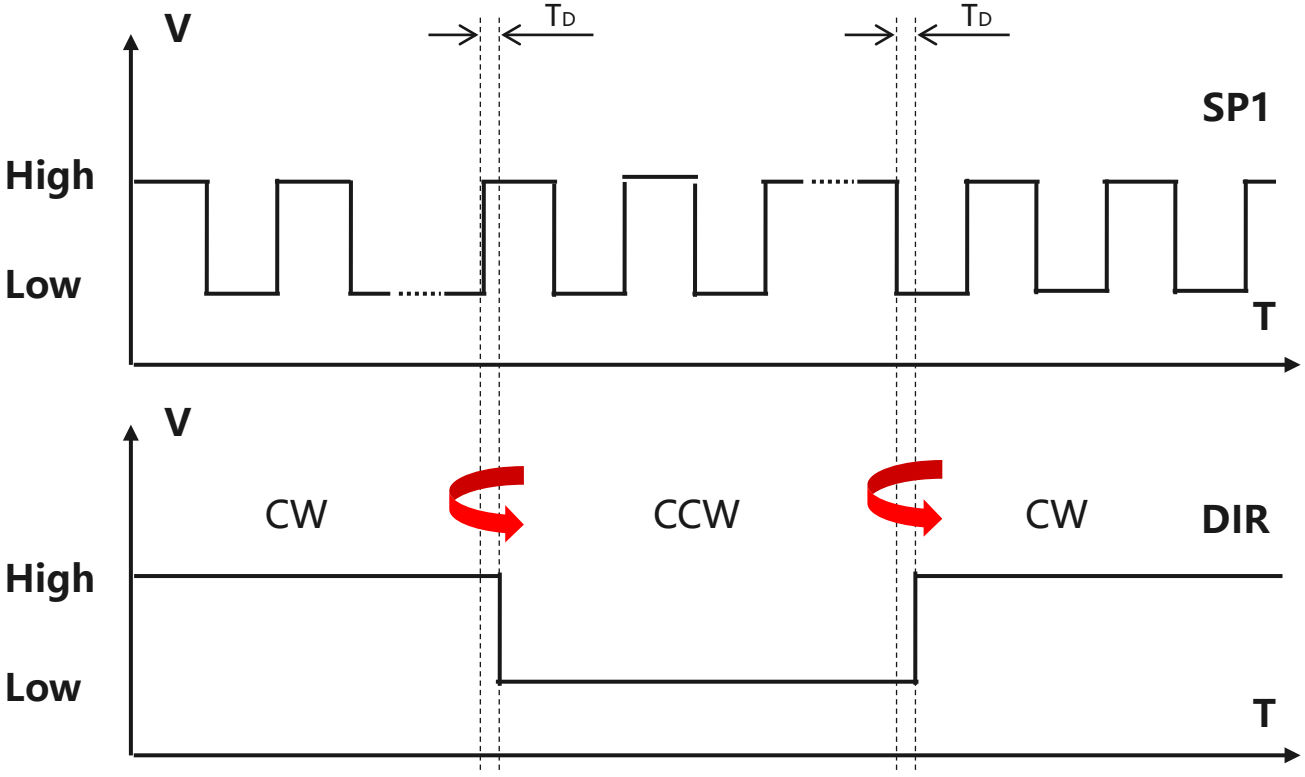


Figure.8

9.1 MT8901-SD Typical Output Waveform (SP1 + DIR Mode)

MT8901AT-SD as example

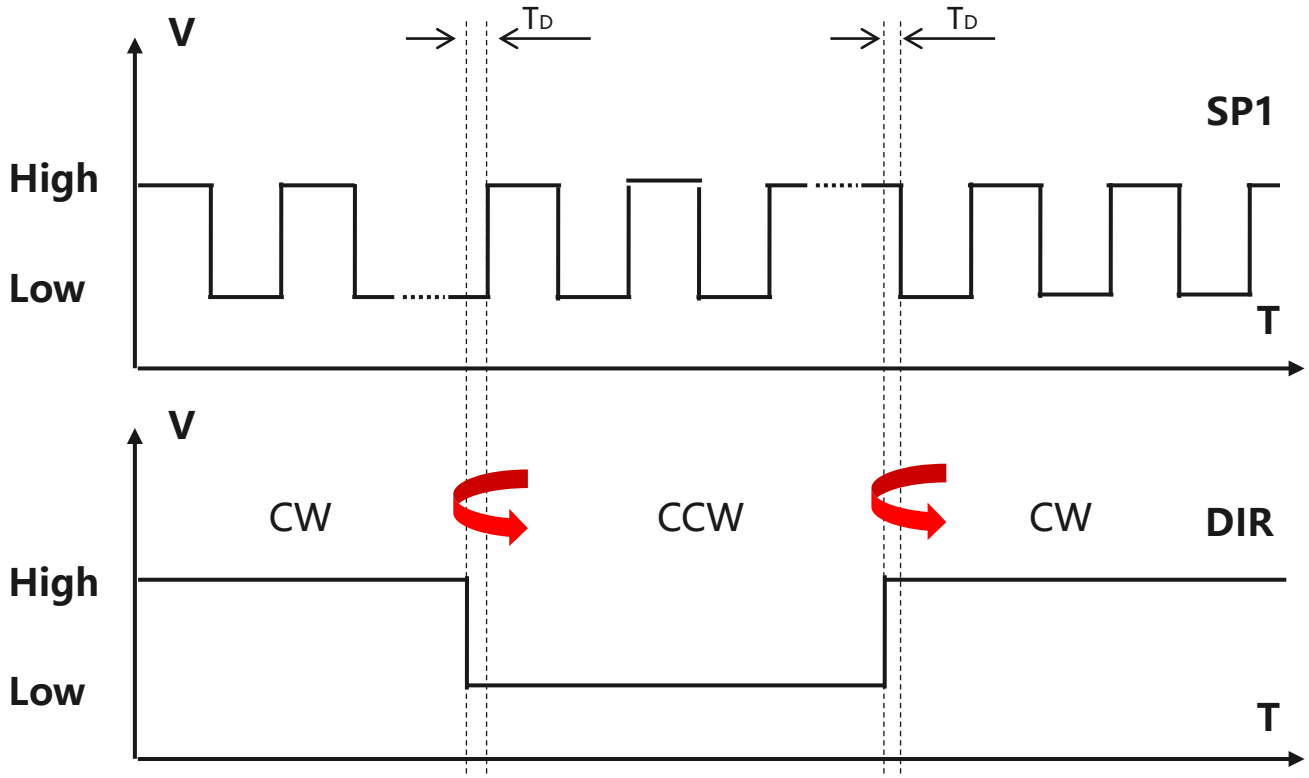


Note:
The DIR phase of MT8901-SD lags the SP1 phase by typical 1.2μs

Figure.9

9.2 MT8902-SD Typical Output Waveform (SP1 + DIR Mode)

MT8902AT-SD as example



Note:
The DIR phase of MT8902-SD leads the SP1 phase by typical 1.2μs

Figure.10

10 Typical Application Circuit

MT890XAT as example
Note: Recommended value for R_{L1} & R_{L2} is 5KOhms to 20KOhms

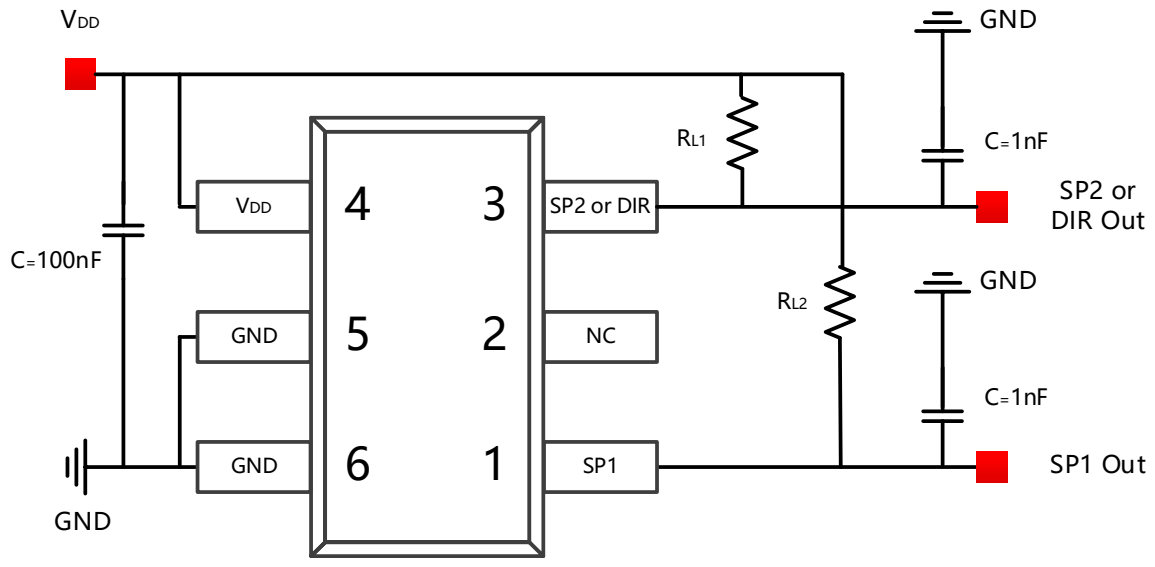


Figure.11 Typical Application Circuit

11 Self-diagnosis

The MT890X 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.7, in which a host is required to control the VDD and SP1 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 SP1 output (VOUT1) low.

Then the host powers on the sensor, and the host I/O has to release the VOUT1 afterwards. Referring to the self-diagnosis timing diagram in Figure.8, 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.

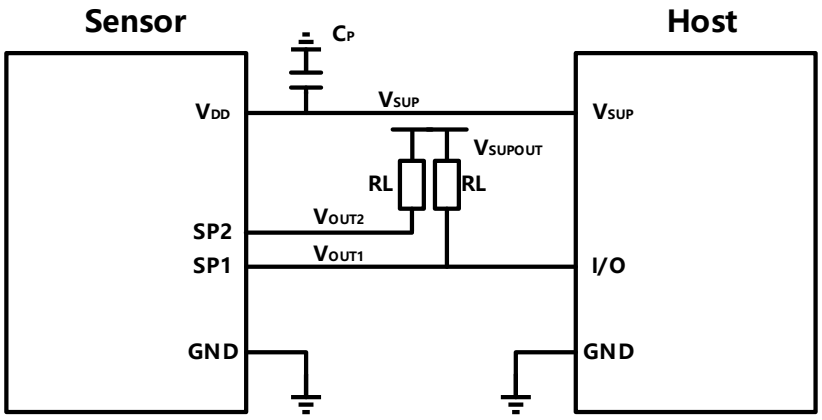
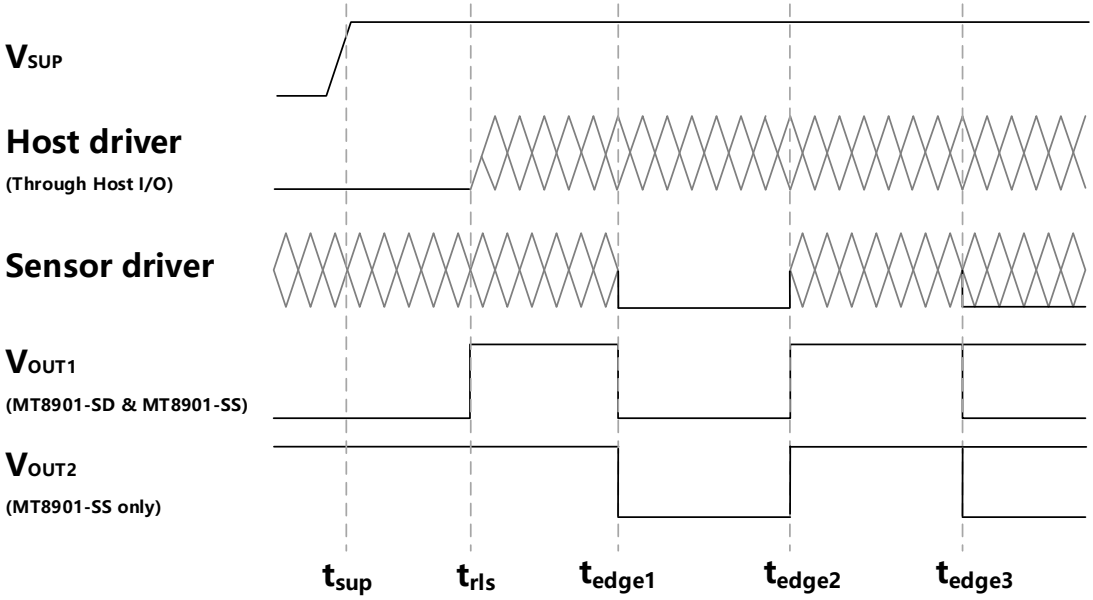


Figure.12 Sensor-Host connection diagram for self-diagnosis function



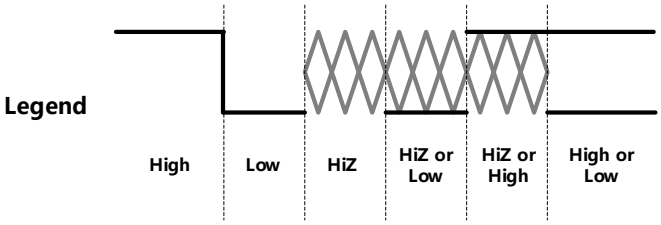


Figure.13 Self-diagnosis timing diagram

11 Self-diagnosis (Continued)

For MT8901-SD, the self-diagnosis function is only available for SP1. If the self-diagnosis function is activated, firstly the VOUT1 will be pulled high by RL since host I/O has released. Then the sensor will generate a first dummy signal that drives the SP1 output low, which simulates an BOP. The falling edge (t_{edge1}) of VOUT1 will be captured by the host. Afterwards the sensor generates a second dummy signal of the opposite polarity that drives the SP1 output high (by RL), which simulates an BRP. The rising edge (t_{edge2}) of VOUT1 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 VOUT1 at t_{edge3}.

For MT8901-SS, the self-diagnosis function is available for both SP1 and SP2. The waveform of VOUT1 is same as MT8901-SD. VOUT2 is initially pulled up by the RL (not controlled by the host). Since t_{edge1}, VOUT2 waveform will be the same as VOUT1, until t_{edge3}, when the first real data of SP2 is sent to VOUT2.

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.

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

12.1 SOT-23-6L Package Information

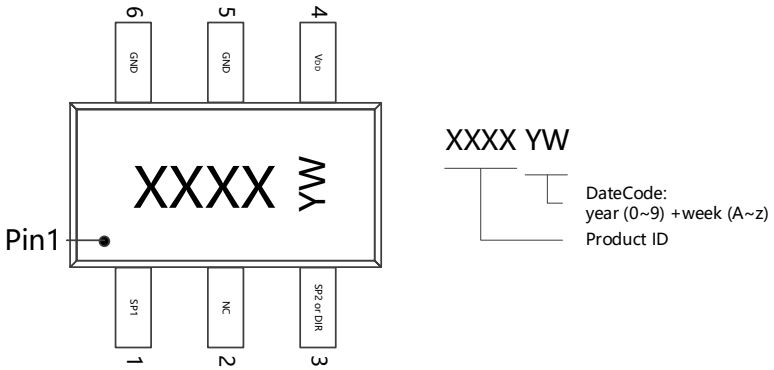


Figure.14 SOT-23-6L Chip Marking Spec

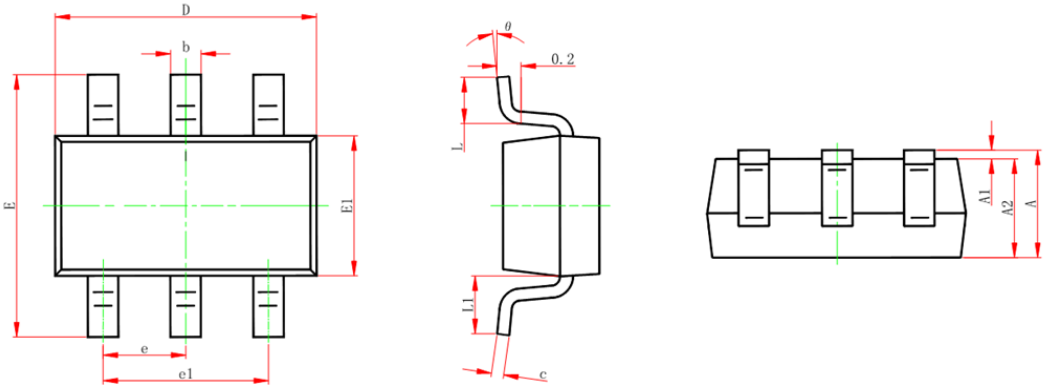


Figure.15 SOT-23-6L Package Drawing

Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E1	1.500	1.700	0.059	0.067
E	2.650	2.950	0.104	0.116
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
L1	0.600 TYP		0.024 TYP	
θ	0°	8°	0°	8°

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

12.2 Flat TO-94 Package Information

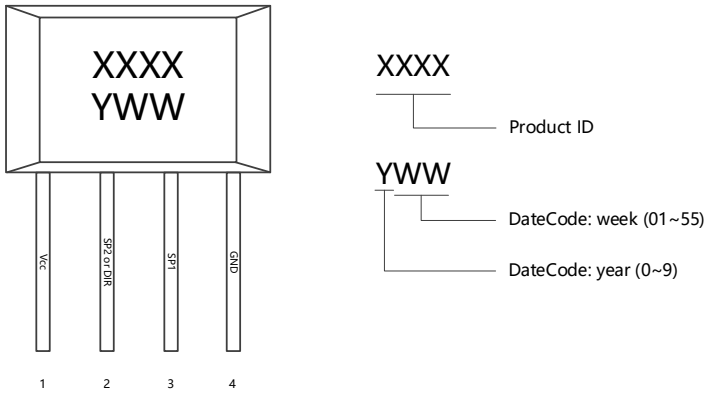


Figure.16 Flat TO-94 Chip Marking Spec

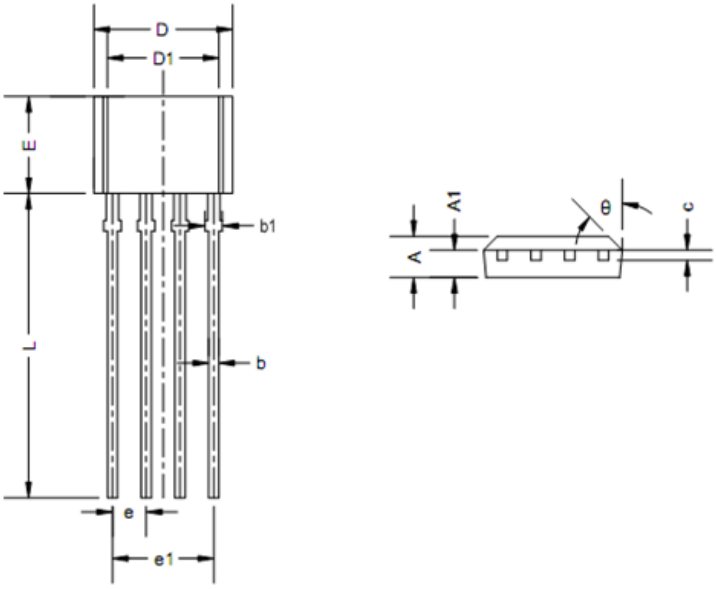


Figure.17 Flat TO-94 Package Drawing

Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.400	1.800	0.055	0.071
A1	0.700	0.900	0.028	0.035
b	0.360	0.500	0.014	0.020
b1	0.380	0.550	0.015	0.022
c	0.360	0.510	0.014	0.020
D	4.980	5.280	0.196	0.208
D1	3.780	4.080	0.149	0.161
E	3.450	3.750	0.136	0.148
e	1.270 TYP		0.050 TYP	
e1	3.710	3.910	0.146	0.154
L	14.900	15.300	0.587	0.602
θ	45°		45°	

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