MT1401-EN

Latch, Hall-Effect Magnetic Position Sensor

1 Product Description

The MT1401-EN family is 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 2.8V to 24V, a small-signal amplifier, Hall sensors with dynamic offset cancellation, a schmitt trigger and an open-drain output with over-current protection. It features temperature compensation technique to make the magnetic switching points stable over a wide temperature range. Other key features such as reverse supply voltage protection, output over-current protection and ESD level exceeding ±6KV (HBM) make the IC extremely robust and fault tolerant, which is important in demanding application environment such as automotive. Its extremely low operating supply voltage 2.8V also makes it possible to add external resistance in series with the supply pin for even greater protection against high voltage transients from the power supply.

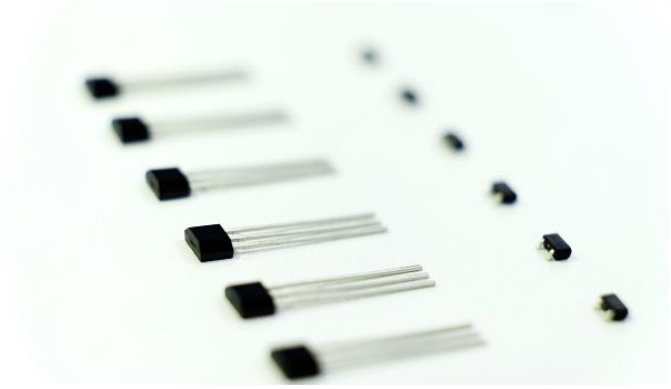
When the magnetic flux density (B) is greater than the operating point (B_{OP}), the output turns on (Low). The output is held steady till the magnetic flux density (B) is less than the releasing point (B_{RP}), at which point it turns off (High).

2 Features

- BCD Technology
- Latch Switch
- 2.8~24V Operating Vcc Range
- -40℃~150℃ Operating Temperature
- Magnetic Sensitivity Option:
  B_{OP}=24Gs, B_{RP}=-24Gs
- Open-Drain Output
- -27V Reversed Power Supply Protection
- Output Limiting Current Protection
- RoHS Compliant: (EU)2015/863

3 Product Overview of MT1401-EN

Part No.	Description
MT1401A-EN	Flat TO-92, bulk packaging (1000pcs/bag)
MT1401A-T-EN	Flat TO-92, radial lead, bulk packaging (1000pcs/bag)
MT1401AT-EN	SOT-23, tape & reel (3000pcs/bag)
MT1401ET-EN	SOT-23 (Thin Outline), tape & reel (3000pcs/bag)
MT1401BT-EN	SOT-89B, tape & reel (1000pcs/bag)



4 Applications

- Home appliances，Industrial
- DC Fan, Electric tools
- Magnetic Encoder

5. Pin Configuration and Functions

	Vcc	Out	GND
SOT-23	1	2	3
SOT-23 (Thin Outline)	1	2	3
Flat TO-92 (Radial Lead)	1	3	2
Flat TO-92	1	3	2
SOT-89B	1	3	2
Description	Power	Output Open-Drain	Ground

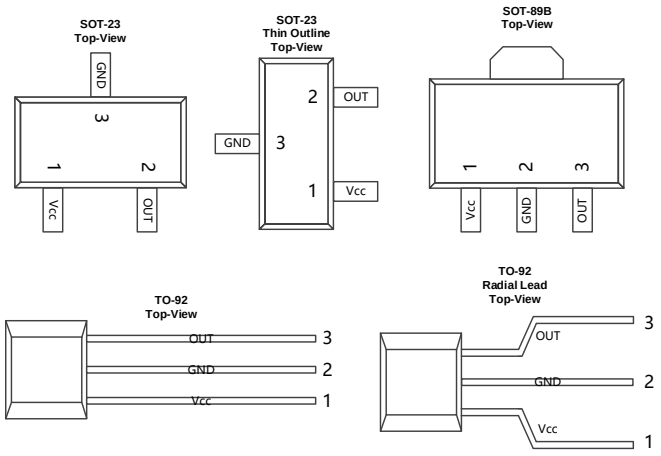


Figure 1 Pin Configuration & Functions

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Reversion History

1	Originally Version	
2	1.1 Version	Update format Update the marking spec of SOT-23 & SOT-23 (Thin Outline)

6 Definition of Switching Function

Figure.2 & Figure.3 shows the device functionality and hysteresis

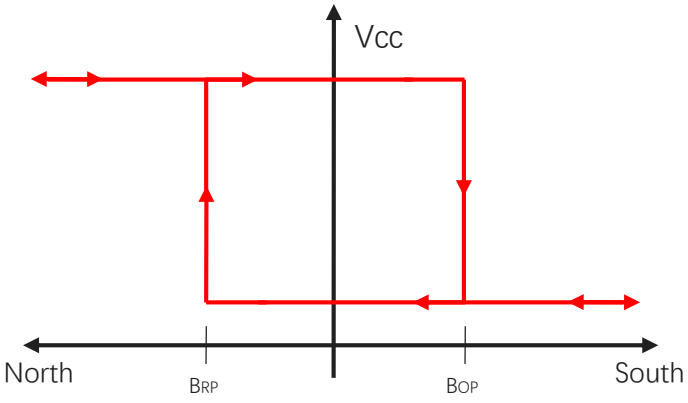


Figure.2 Switching Function of Flat TO-92 & SOT-89B & SOT-23 (Thin Outline)

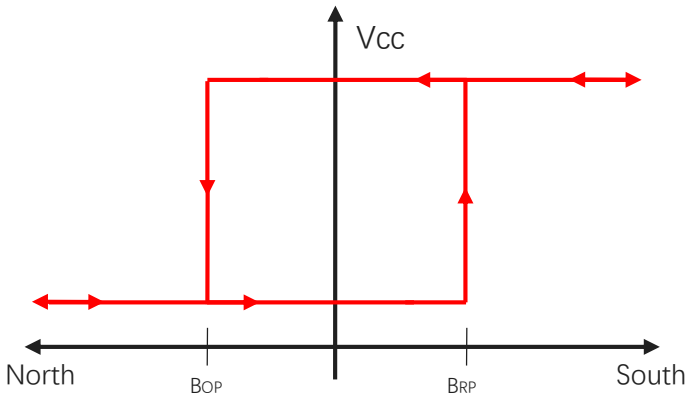


Figure.3 Switching Function of SOT-23

7 Function Description

BOP: Operating Point, Magnetic flux density applied on the branded side of the package which turns the output driver ON (VOUT=Low)

BRP: Releasing Point, Magnetic flux density applied on the branded side of the package which turns the output driver OFF (VOUT=High)

BHYST: Hysteresis Window, |BOP - BRP|
Devices that have a lower magnetic threshold (VOUT=High) detect magnets at a farther distance. Higher thresholds (VOUT=Low) generally require a closer distance or larger magnet.

8 Feature Description

The MT1401-EN device is sensitive to the magnetic field component that is perpendicular to the top of the package

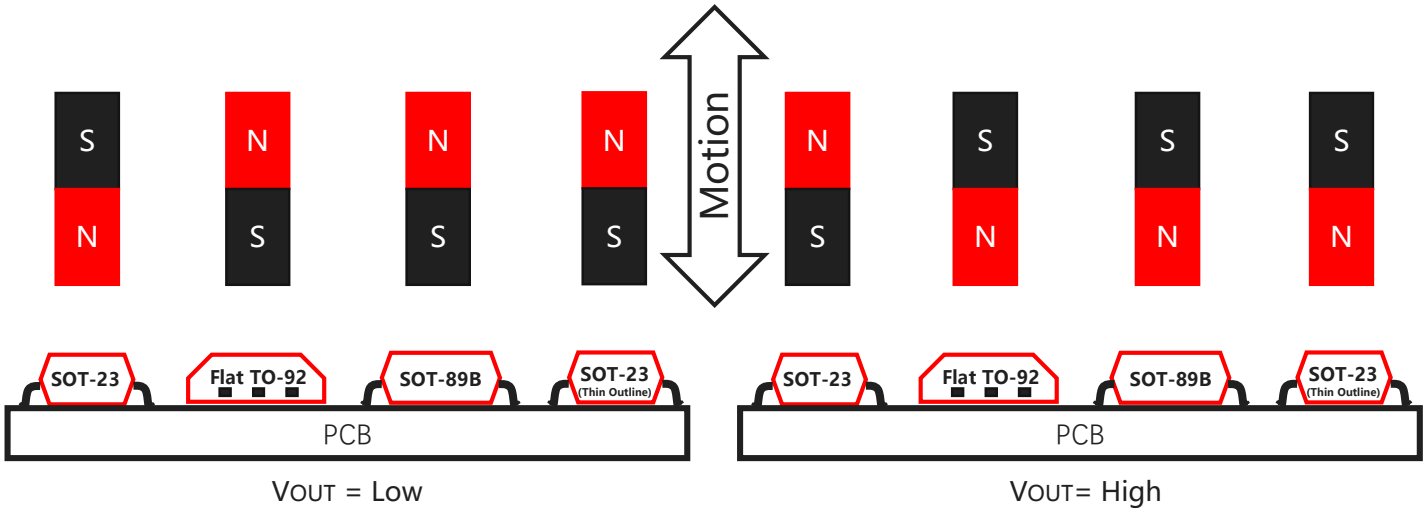


Figure.4 Flux Direction Polarity

9 Functional Block Diagram

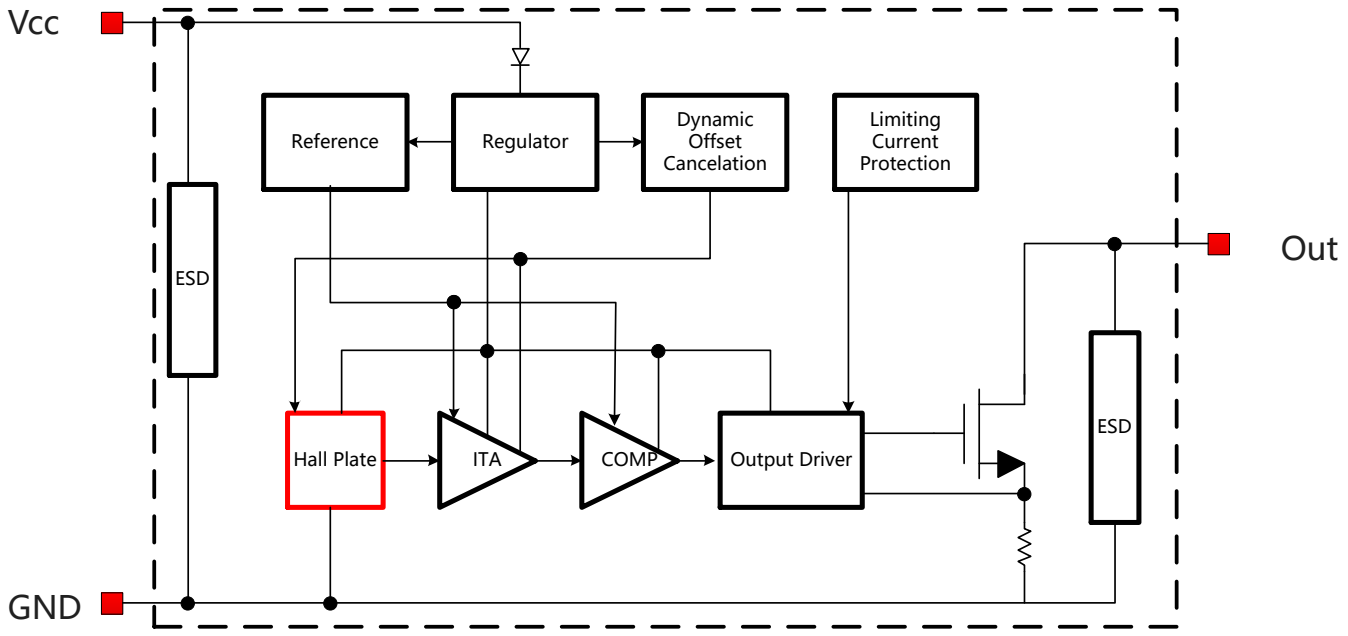


Figure.5 Functional Block Diagram

10 Electrical and Magnetic Characteristics

10.1 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_{CC}	Supply Voltage	-	27	V
V_{RCC}	Reverse Battery Voltage	-27	-	V
V_{OUT}	Output Voltage	-	27	V
I_{OUT}	Continuous Output Current	-	50	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

10.2 Electrical Specifications

At T_A=-40~150 ℃, V_{CC}=2.8V~24V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
V_{CC}	Supply Voltage	Operating	2.8	-	24	V
I_{CC}	Supply Current	B<B_{RP}	1	2.3	3.5	mA
I_{OCP}	Short Circuit Protection Current	B>B_{OP}, V_{OUT}=V_{CC}	-	50	-	mA
V_{DSON}	Output Saturation Voltage	I_{OUT}=20mA, B>B_{OP}	-	-	0.4	V
I_{OFF}	Output Leakage Current	V_{OUT}=24V	-	-	10	uA
T_R	Output Rise Time	R_L=1KOhm, C_L=20pF	-	-	1.0	us
T_F	Output Fall Time	R_L=1KOhm, C_L=20pF	-	-	1.0	us
T_{PO}	Power on Time	dV_{CC}/dt>5V/uS B>$B_{OP(MAX)}$	-	-	10	us
F_C	Chopping Frequency		-	800	-	KHz
F_S	Sampling Frequency		-	400	-	KHz
R_{TH}	Thermal Resistance of SOT-23		-	301	-	℃/W
	Thermal Resistance of SOT-23 (Thin Outline)		-	301	-	℃/W
	Thermal Resistance of SOT-89B		-	230	-	℃/W
	Thermal Resistance of TO-92		-	230	-	℃/W

10.3 Magnetic Characteristics

At V_{CC}=2.8V~24V (unless otherwise specified)

Part No.	Symbol	Min	Typ	Max	Unit
MT1401-EN Series	B_{OP}, T_A =25℃	5	24	40	Gs
	B_{RP}, T_A =25℃	-40	-24	-5	Gs
	B_{HYST}, T_A =25℃	10	48	80	Gs

10.4 ESD Ratings

Symbol		Reference	Values	Unit
V_{ESD}	Human-body model (HBM)	AEC-Q100-002	±6000	V
	Charged-device model (CDM)	AEC-Q100-011	±1000	V

10.5 Characteristic Performance

At Vcc=5V

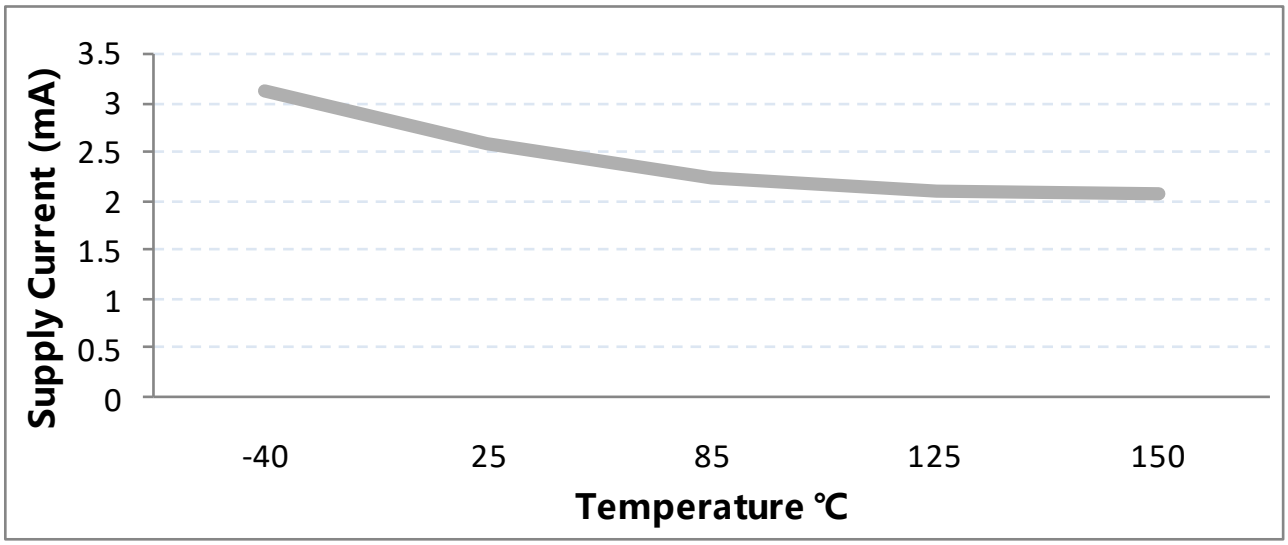


Figure.6 Supply Current vs. Temperature

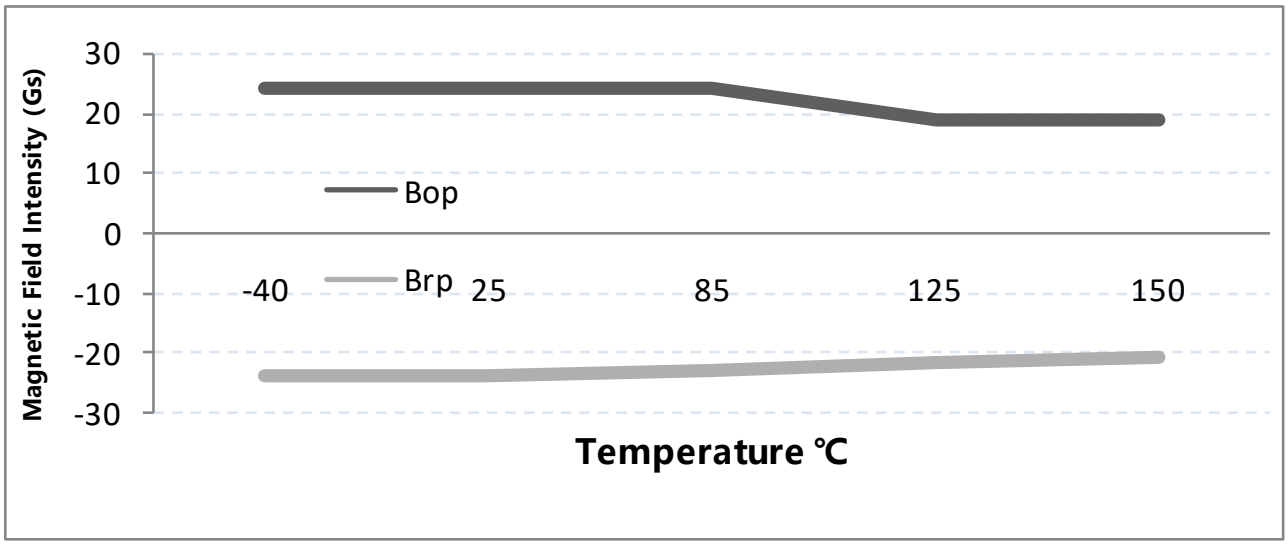


Figure.7 Magnetic Characteristics vs. Temperature (BOP & BRP)

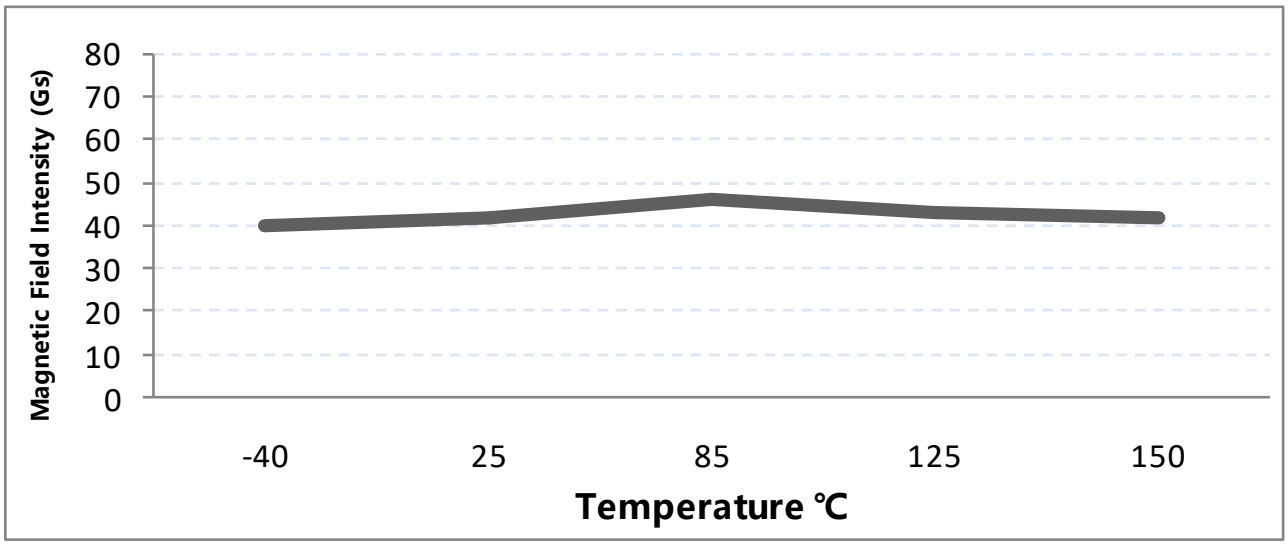


Figure.8 Magnetic Characteristics vs. Temperature (BHYST)

10.6 Typical Output Waveform

MT1401A-EN as example

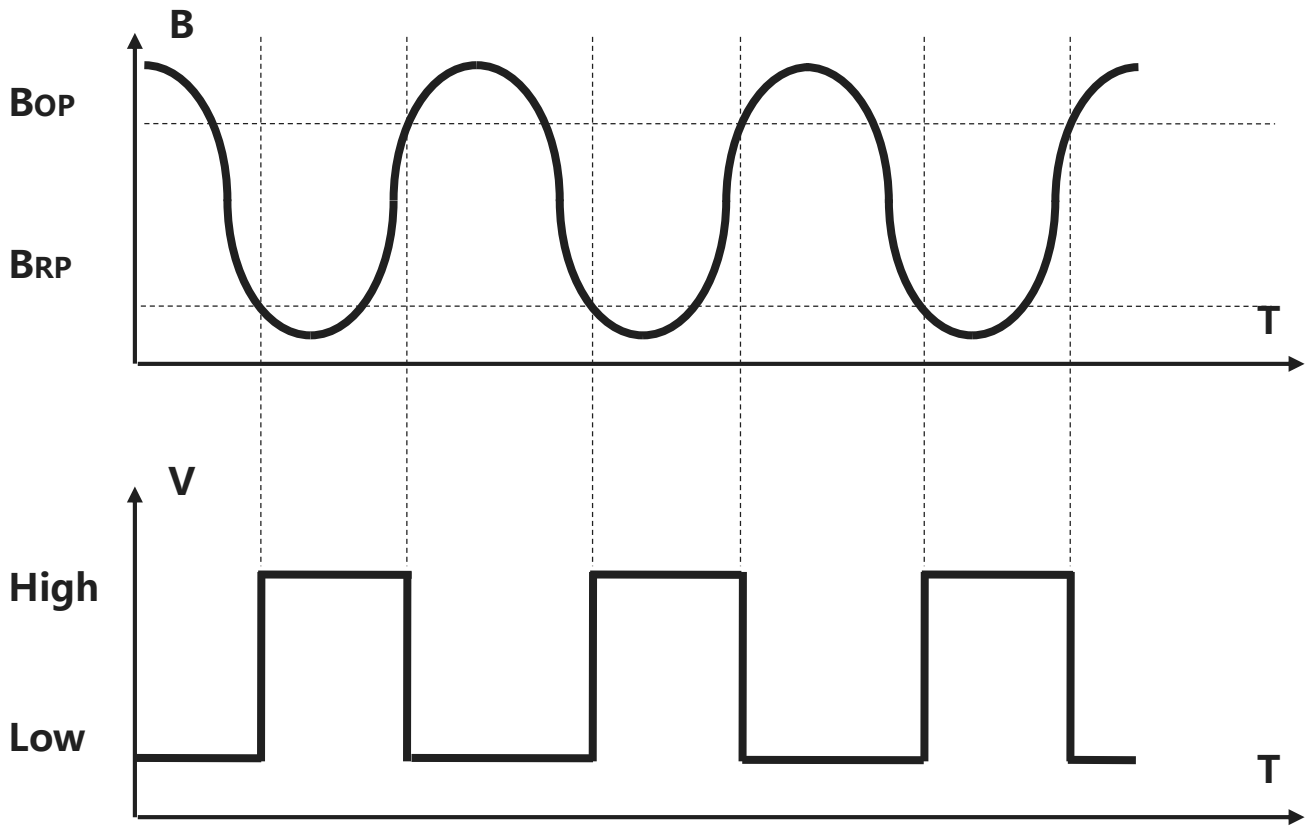


Figure.9 Digital Output vs. Magnetic Flux Density

11 Typical Application Circuit

MT1401AT-EN as example
Note: Recommended value for R_L is 1KOhms to 10KOhms

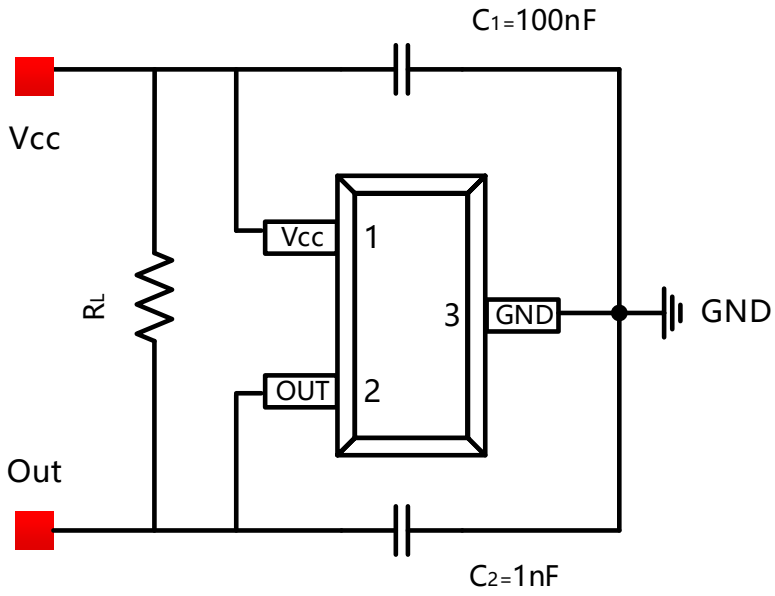


Figure.10 Typical Application Circuit

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

12.1 SOT-23 Package Information

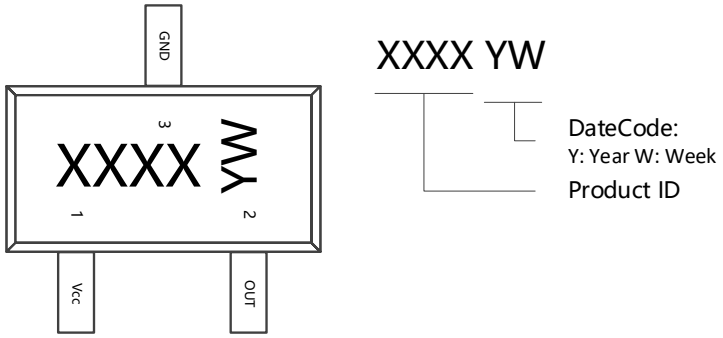


Figure.11 SOT-23 Chip Marking Spec

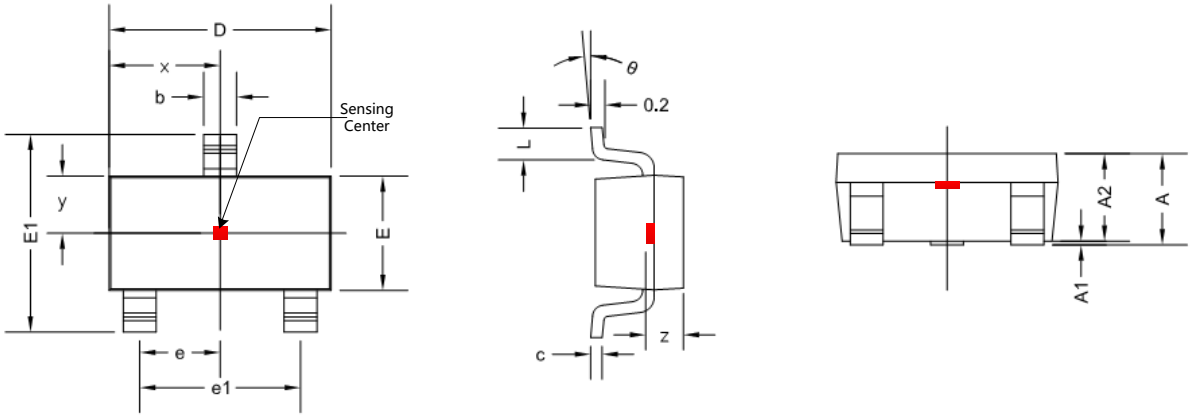


Figure.12 SOT-23 Package Drawing

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
E	1.500	1.700	0.059	0.067
E1	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
θ	0 °	8 °	0 °	8 °
x	1.460 TYP		0.057 TYP	
y	0.800 TYP		0.032 TYP	
z	0.600 TYP		0.024 TYP	

12.2 SOT-23 (Thin Outline) Package Information

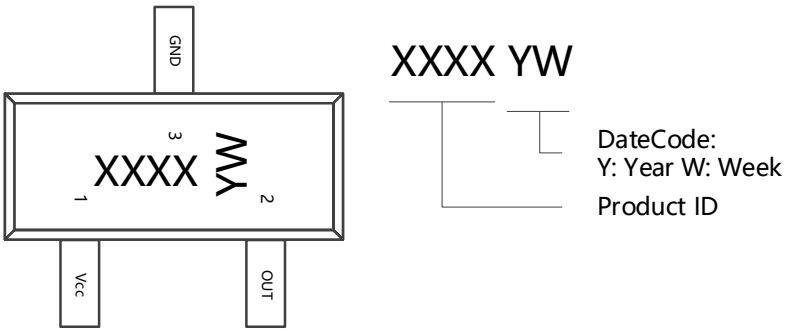


Figure.13 SOT-23 (Thin Outline) Chip Marking Spec

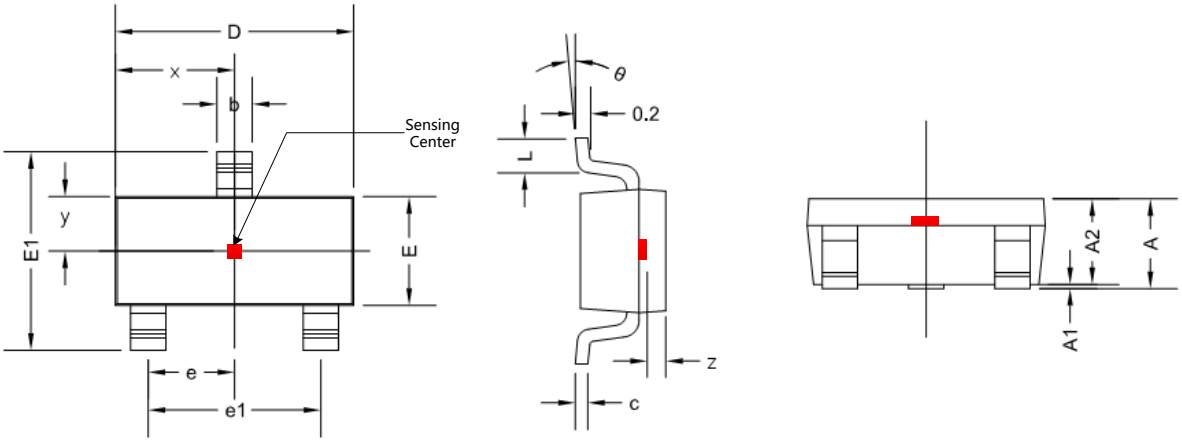


Figure.14 SOT-23 (Thin Outline) Package Drawing

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	1.050	0.035	0.041
b	0.300	0.500	0.012	0.020
c	0.080	0.150	0.003	0.006
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		1.460 TYP		0.057 TYP
y		0.650 TYP		0.026 TYP
z		0.500 TYP		0.020 TYP

12.3 Flat TO-92 Package Information

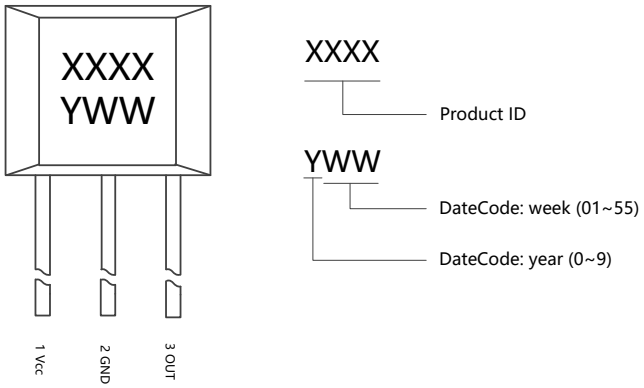


Figure.15 Flat TO-92 Chip Marking Spec

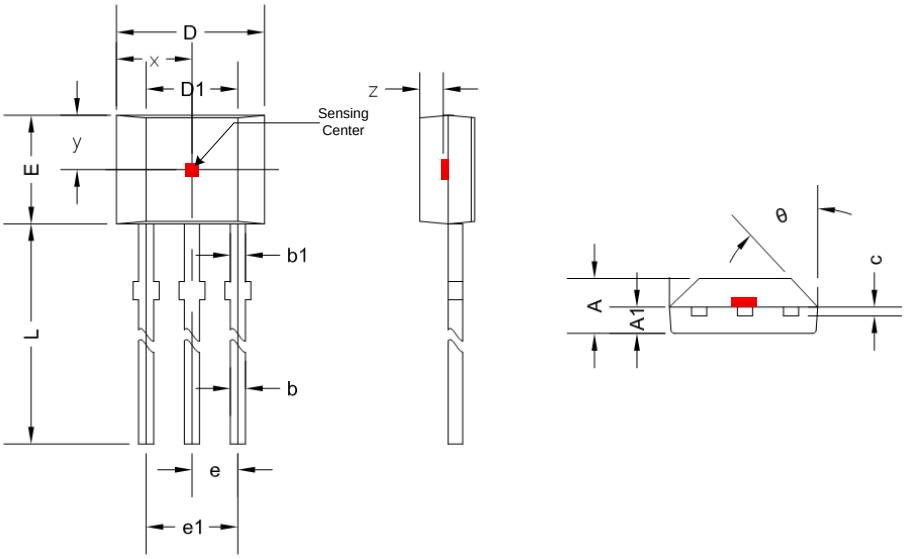


Figure.16 Flat TO-92 Package Drawing

Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.420	1.620	0.056	0.064
A1	0.660	0.860	0.026	0.034
b	0.350	0.480	0.013	0.019
b1	0.400	0.510	0.016	0.020
c	0.330	0.510	0.013	0.020
D	3.900	4.100	0.154	0.161
D1	2.280	2.680	0.090	0.106
E	3.050	3.250	0.120	0.128
e	1.270 TYP		0.050 TYP	
e1	2.440	2.640	0.096	0.104
L	14.350	14.750	0.565	0.581
θ	45 ° TYP		45 ° TYP	
x	2.025 TYP		0.080 TYP	
y	1.545 TYP		0.061 TYP	
z	0.500 TYP		0.020 TYP	

12.4 Flat TO-92 Package Information (Radial Lead)

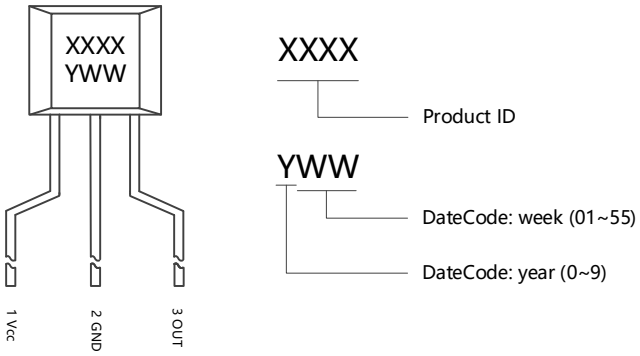


Figure.17 Flat TO-92 (Radial Lead) Chip Marking Spec

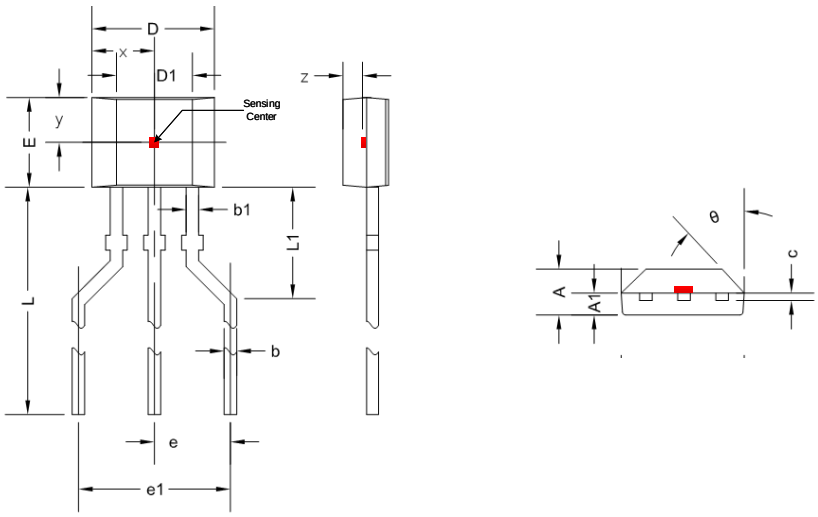


Figure.18 Flat TO-92 (Radial Lead) Package Drawing

Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.420	1.620	0.056	0.064
A1	0.660	0.860	0.026	0.034
b	0.350	0.480	0.013	0.019
b1	0.400	0.510	0.016	0.020
c	0.330	0.510	0.013	0.020
D	3.900	4.100	0.154	0.161
D1	2.280	2.680	0.090	0.106
E	3.050	3.250	0.120	0.128
e	2.540 TYP		0.100 TYP	
e1	5.000 TYP		0.197 TYP	
L1	2.000 TYP		0.079 TYP	
L	13.88 TYP		0.546 TYP	
θ	45 ° TYP		45 ° TYP	
x	2.025 TYP		0.080 TYP	
y	1.545 TYP		0.061 TYP	
z	0.500 TYP		0.020 TYP	

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12.5 SOT-89B Package Information

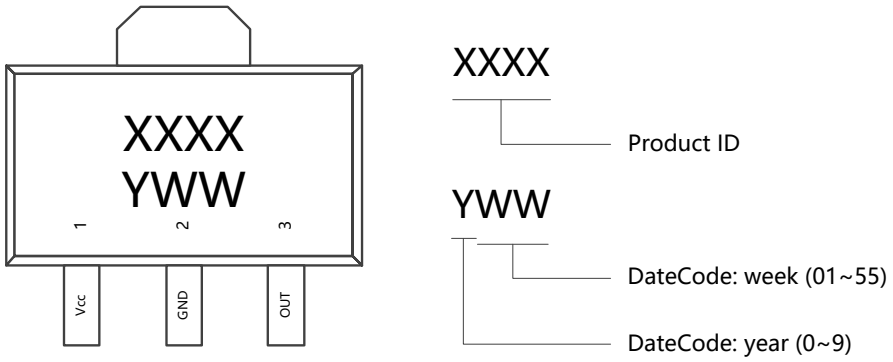


Figure.19 SOT-89B Chip Marking Spec

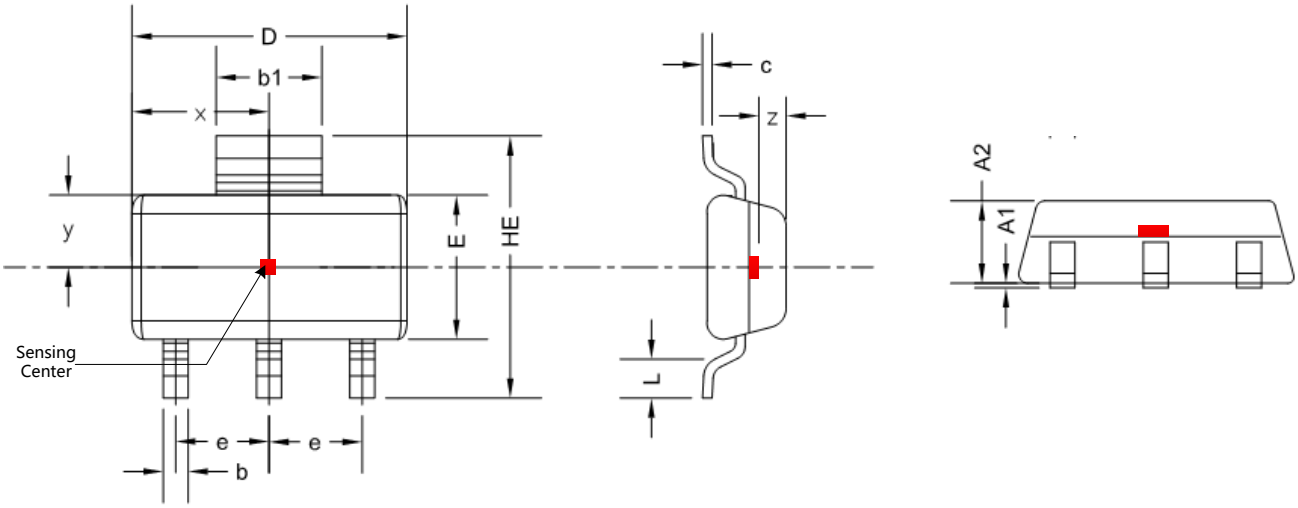


Figure.20 SOT-89B Package Drawing

Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A2	1.220	1.420	0.048	0.056
A1	0.000	0.100	0.000	0.004
b	0.300	0.500	0.012	0.020
c	0.052	0.252	0.002	0.010
D	4.400	4.600	0.173	0.181
b1	1.600	1.800	0.063	0.071
E	2.400	2.600	0.094	0.102
HE	4.000	4.400	0.157	0.173
e	1.400	1.600	0.055	0.063
L	0.350	0.550	0.014	0.022
x	2.250 TYP		0.089 TYP	
y	1.250 TYP		0.049 TYP	
z	0.300 TYP		0.012 TYP	

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