

# Uni-polar, High Voltage Hall-Effect Switch IC

## 1 Product Description

The MT831X 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 3.8V to 60V, temperature compensation circuitry, small-signal amplifier, Hall IC with dynamic offset cancellation system, Schmitt trigger and an open collector output. It also includes a clamp diode at output and reversed power supply protection enhances the robustness of Hall IC.

The Hall IC designed to respond to a single poles. While the magnetic flux density(B) is larger than operating point (BOP), the output will be turned on (Low), the output is held until the magnetic flux density(B) is lower than releasing point (BRP), then turn off (High).

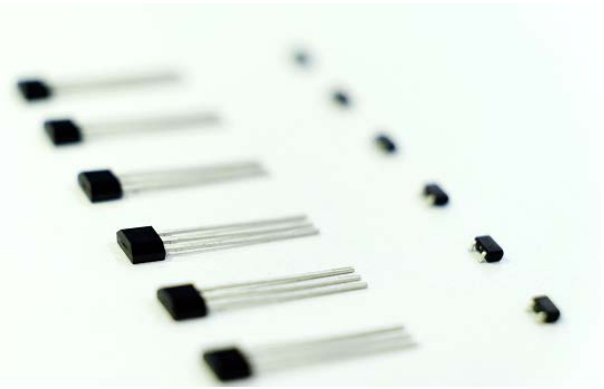
The MT831X family provides a variety of packages to customers: SOT-23/SOT-23 (Thin Outline)/SOT-89-3L for surface mount and flat TO-92 for through-hole mount. All packages are RoHS compliant.

## 2 Features

- AEC-Q100 Automotive Qualified MT831XAT & MT831XET
- Uni-polar Switch
- 3.8~60V Operating Vcc Range
- -40°C~150°C Operating Temperature
- Package Option:  
Flat TO-92 / Flat TO-92 (Radial Lead) / SOT-23 / SOT-23 (Thin Outline) / SOT-89-3L
- Magnetic Sensitivity Option:  
MT8311 (BOP=140Gs, BRP=105Gs)  
MT8312 (BOP=255Gs, BRP=210Gs)  
MT8313 (BOP=85Gs, BRP=50Gs)  
MT8315 (BOP=30Gs, BRP=20Gs)
- Open-Drain Output
- -20V Reversed Power Supply Protection
- Output Limiting Current Protection
- RoHS Compliant: (EU)2015/863

## 3 Product Overview of MT831X

| Part No.  | Description   |
|-----------|---|
| MT831XA   | Flat TO-92, bulk packaging (1000pcs/bag)              |
| MT831XA-T | Flat TO-92, radial lead, bulk packaging (1000pcs/bag) |
| MT831XAT  | SOT-23, tape & reel (3000pcs/bag)                     |
| MT831XET  | SOT-23 (Thin Outline), tape & reel (3000pcs/bag)      |
| MT831XBT  | SOT-89-3L, tape & reel (1000pcs/bag)                  |



## 4 Applications

- Automotive, Home appliances, Industrial
- Speed Detection
- Position Detection
- Magnetic Encoder
- Solid-State Switch
- Proximity Switch

## 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-89-3L                | 1     | 3                 | 2      |
| Description              | Power | Output Open-Drain | Ground |

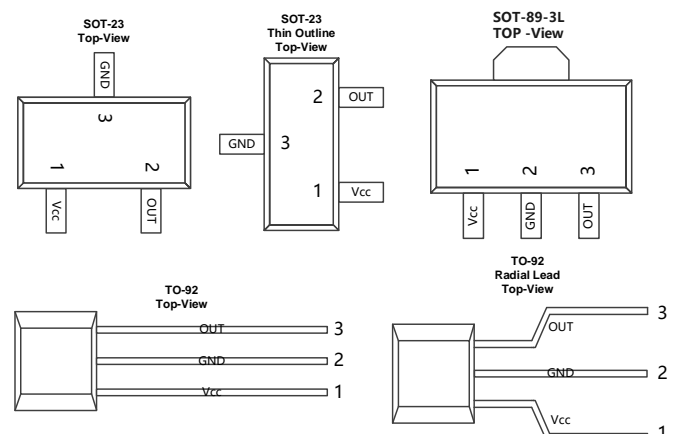


Figure.1 Pin Configuration & Functions

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## Reversion History

|    |                    |   |
|----|--------------------|---|
| 1  | Originally Version |   |
| 2  | 1.1 Version        | Update MT8312 & MT8313 Series                             |
|    |                    | Update SOT-23 (Thin Outline) Package                      |
| 3  | 1.2 Version        | Update Flat TO-92 (Radial Lead) Package                   |
| 4  | 1.3 Version        | Update AEC-Q100 Automotive on MT831XAT                    |
| 5  | 1.4 Version        | Update RoHS compliant to (EU)2015/863                     |
| 6  | 1.5 Version        | Update AEC-Q100 Logo                                      |
|    |                    | Update Copy Rights and Disclaimer                         |
| 7  | 1.6 Version        | Update AEC-Q100 Automotive on MT831XET                    |
| 8  | 1.7 Version        | Update MT8315 Series                                      |
| 9  | 1.8 Version        | Update the Marking Spec of SOT-23 & SOT-23 (Thin Outline) |
| 10 | 1.9 Version        | Update the Characteristic Performance                     |
| 11 | 2.0 Version        | Update the Logo of MagnTek                                |
| 12 | 2.1 Version        | Update SOT-89-3L Package Outline                          |

## 6 Definition of Switching Function

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

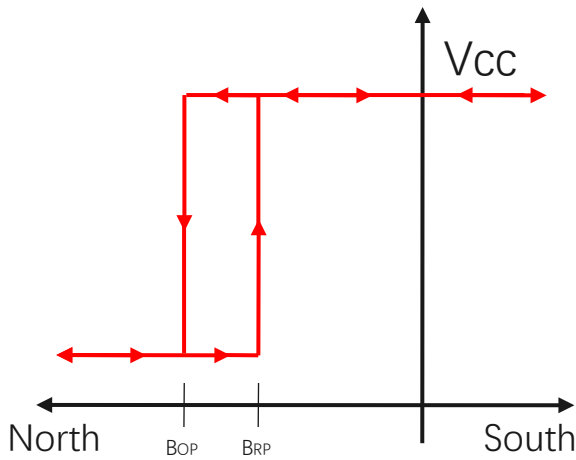


Figure.2 Switching Function Uni-polar (North)  
SOT-23

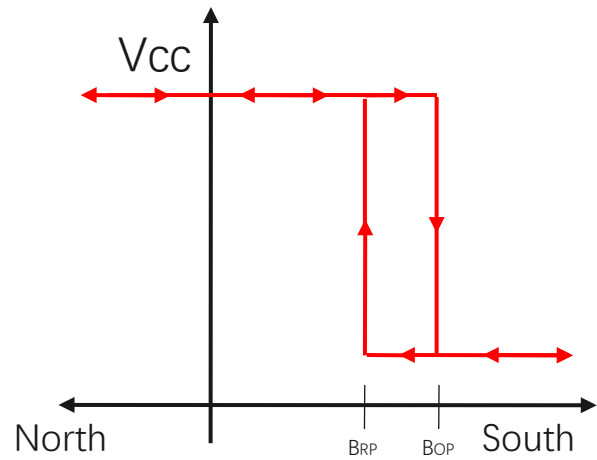


Figure.3 Switching Function Uni-polar (South)  
SOT-23 (Thin Outline) / Flat TO-92 / SOT-89-3L

## 7 Function Description

**B<sub>OP</sub>:** Operating Point, Magnetic flux density applied on the branded side of the package which turns the output driver ON ( $V_{OUT}=Low$ )

**B<sub>RP</sub>:** Releasing Point, Magnetic flux density applied on the branded side of the package which turns the output driver OFF ( $V_{OUT}=High$ )

**B<sub>HYST</sub>:** 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.

## 8 Feature Description

The MT831X device is sensitive to the magnetic field component that is perpendicular to the top of the package

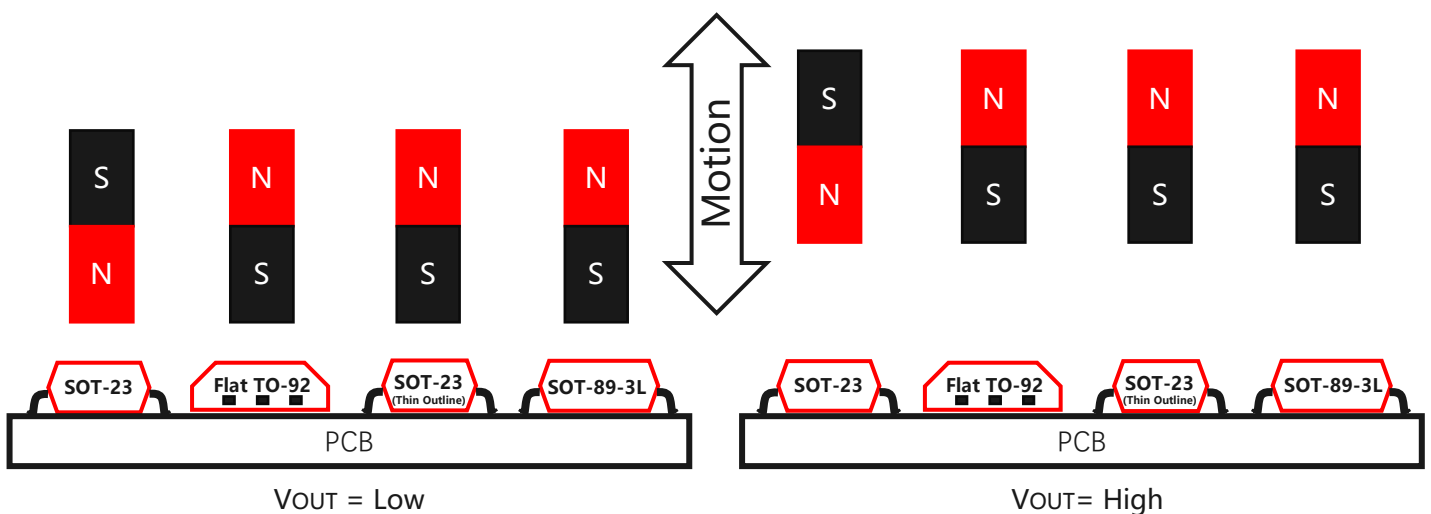


Figure.4 Flux Direction Polarity

## 9 Functional Block Diagram

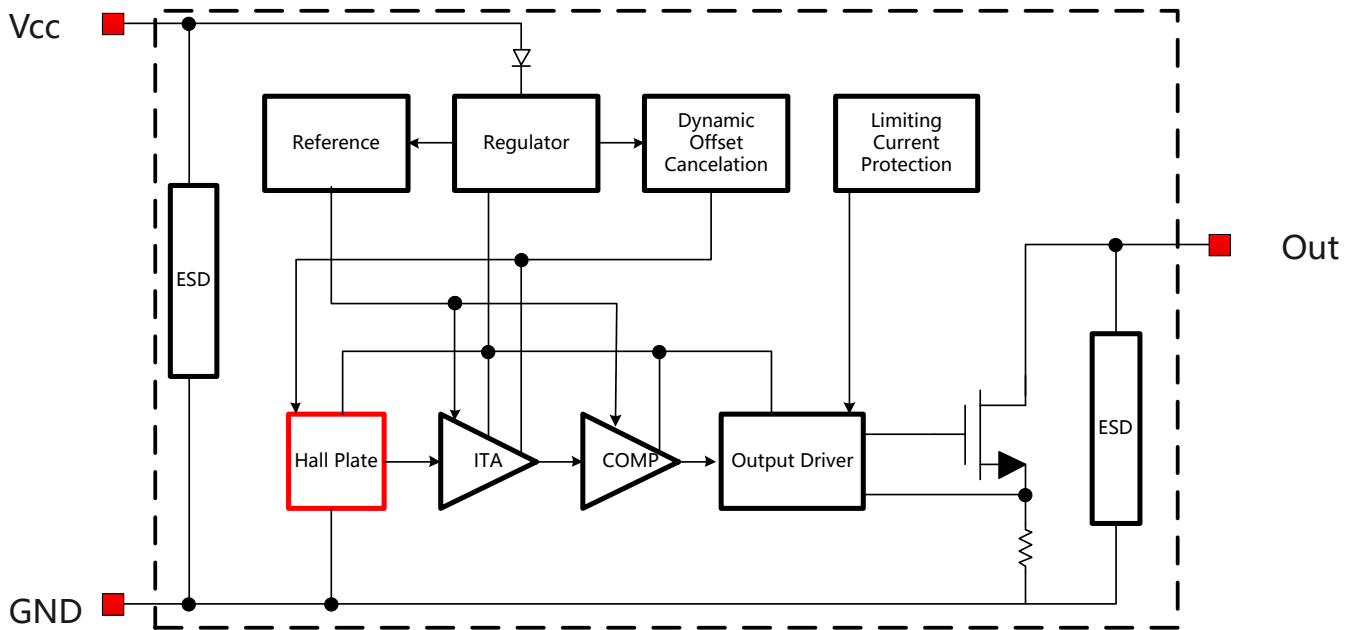


Figure.5 Functional Block Diagram

## 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 <sub>CC</sub>  | Supply Voltage                | -        | 65  | V     |
| V <sub>RCC</sub> | Reverse Battery Voltage       | -20      | -   | V     |
| V <sub>OUT</sub> | Output Voltage                | -        | 65  | V     |
| I <sub>OUT</sub> | Continuous Output Current     | -        | 40  | mA    |
| T <sub>A</sub>   | Operating Ambient Temperature | -40      | 150 | °C    |
| T <sub>S</sub>   | Storage Temperature           | -50      | 150 | °C    |
| T <sub>J</sub>   | Junction Temperature          | -        | 165 | °C    |
| B                | Magnetic Flux Density         | No Limit |     | Gs    |

### 10.2 ESD Ratings

| Symbol           | Reference                  | Values       | Unit           |
|------------------|----------------------------|--------------|----------------|
| V <sub>ESD</sub> | Human-body model (HBM)     | AEC-Q100-002 | Class II Grade |
|                  | Charged-device model (CDM) | AEC-Q100-011 | Class C6 Grade |

### 10.3 Electrical Specifications

At  $T_A = -40 \sim 150 \text{ }^\circ\text{C}$ ,  $V_{CC} = 3.8\text{V} \sim 60\text{V}$  (unless otherwise specified)

| Symbol     | Parameters                                  | Test Condition  | Min | Typ | Max | Unit                      |
|------------|---|---|-----|-----|-----|---------------------------|
| $V_{CC}$   | Supply Voltage                              | Operating   | 3.8 | -   | 60  | V                         |
| $I_{CC}$   | Supply Current                              | $B < B_{RP}$  | -   | 4   | 6   | mA                        |
| $I_{OCP}$  | Short Circuit Protection Current            | $B > B_{OP}$ , $V_{OUT} = V_{CC}$                         | -   | 50  | -   | mA                        |
| $V_{DSON}$ | Output Saturation Voltage                   | $I_{OUT} = 15\text{mA}$ ,<br>$B > B_{OP}$                 | -   | -   | 0.4 | V                         |
| $I_{OFF}$  | Output Leakage Current                      | $V_{OUT} = 24\text{V}$ ,<br>$ B  <  B_{RP} $              | -   | -   | 10  | $\mu\text{A}$             |
| $T_R$      | Output Rise Time                            | $R_L = 1\text{K}\Omega$ ,<br>$C_L = 20\text{pF}$          | -   | -   | 1.0 | $\mu\text{s}$             |
| $T_F$      | Output Fall Time                            | $R_L = 1\text{K}\Omega$ ,<br>$C_L = 20\text{pF}$          | -   | -   | 1.0 | $\mu\text{s}$             |
| $T_{PO}$   | Power on Time                               | $dV_{CC}/dt > 5\text{V}/\mu\text{s}$<br>$B > B_{OP(MAX)}$ | -   | -   | 10  | $\mu\text{s}$             |
| $F_C$      | Chopping Frequency                          |   | -   | 800 | -   | KHz                       |
| $F_S$      | Sampling Frequency                          |   | -   | 200 | -   | KHz                       |
| $R_{TH}$   | Thermal Resistance of SOT-23                |   | -   | 301 | -   | $^\circ\text{C}/\text{W}$ |
|            | Thermal Resistance of SOT-23 (Thin Outline) |   | -   | 301 | -   | $^\circ\text{C}/\text{W}$ |
|            | Thermal Resistance of TO-92                 |   | -   | 230 | -   | $^\circ\text{C}/\text{W}$ |
|            | Thermal Resistance of SOT-89-3L             |   | -   | 250 | -   | $^\circ\text{C}/\text{W}$ |

### 10.4 Magnetic Characteristics

At  $V_{CC} = 3.8\text{V} \sim 60\text{V}$  (unless otherwise specified)

| Part No.      | Symbol                                | Min | Typ | Max | Unit |
|---------------|---------------------------------------|-----|-----|-----|------|
| MT8311 Series | $B_{OP}$ , $T_A = 25^\circ\text{C}$   | 110 | 140 | 170 | Gs   |
|               | $B_{RP}$ , $T_A = 25^\circ\text{C}$   | 75  | 105 | 135 | Gs   |
|               | $B_{HYST}$ , $T_A = 25^\circ\text{C}$ | 20  | 35  | 50  | Gs   |
| MT8312 Series | $B_{OP}$ , $T_A = 25^\circ\text{C}$   | 210 | 255 | 300 | Gs   |
|               | $B_{RP}$ , $T_A = 25^\circ\text{C}$   | 165 | 210 | 255 | Gs   |
|               | $B_{HYST}$ , $T_A = 25^\circ\text{C}$ | 30  | 45  | 60  | Gs   |
| MT8313 Series | $B_{OP}$ , $T_A = 25^\circ\text{C}$   | 60  | 85  | 110 | Gs   |
|               | $B_{RP}$ , $T_A = 25^\circ\text{C}$   | 25  | 50  | 75  | Gs   |
|               | $B_{HYST}$ , $T_A = 25^\circ\text{C}$ | 20  | 35  | 50  | Gs   |
| MT8315 Series | $B_{OP}$ , $T_A = 25^\circ\text{C}$   | 20  | 30  | 40  | Gs   |
|               | $B_{RP}$ , $T_A = 25^\circ\text{C}$   | 10  | 20  | 30  | Gs   |
|               | $B_{HYST}$ , $T_A = 25^\circ\text{C}$ | 3   | 10  | 17  | Gs   |

### 10.5 Characteristic Performance

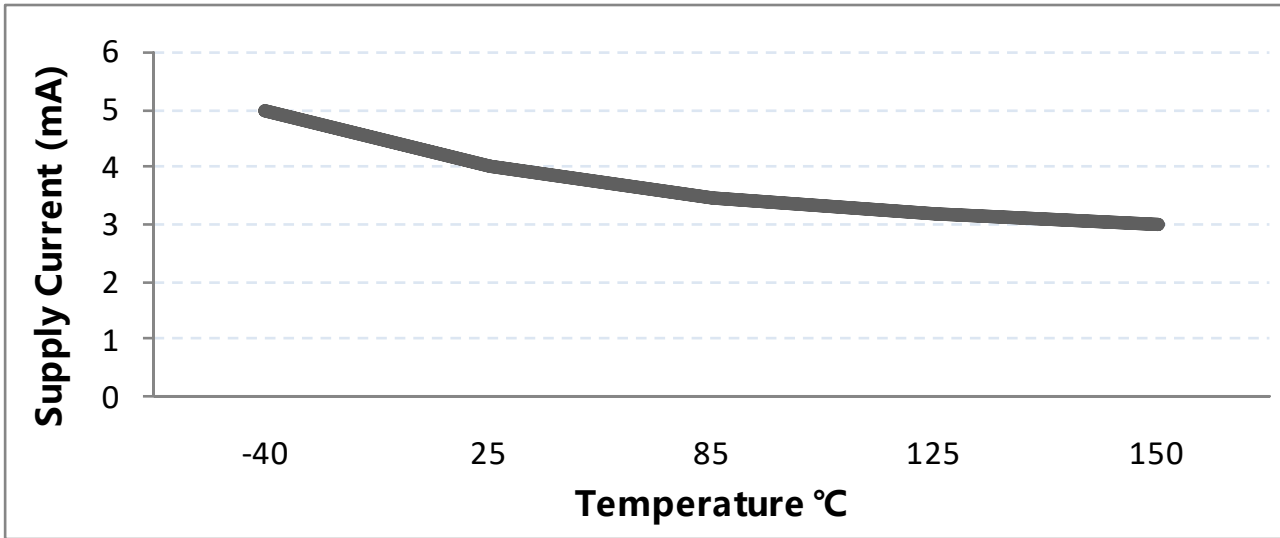


Figure.6 Supply Current vs. Temperature @ Vcc=5V

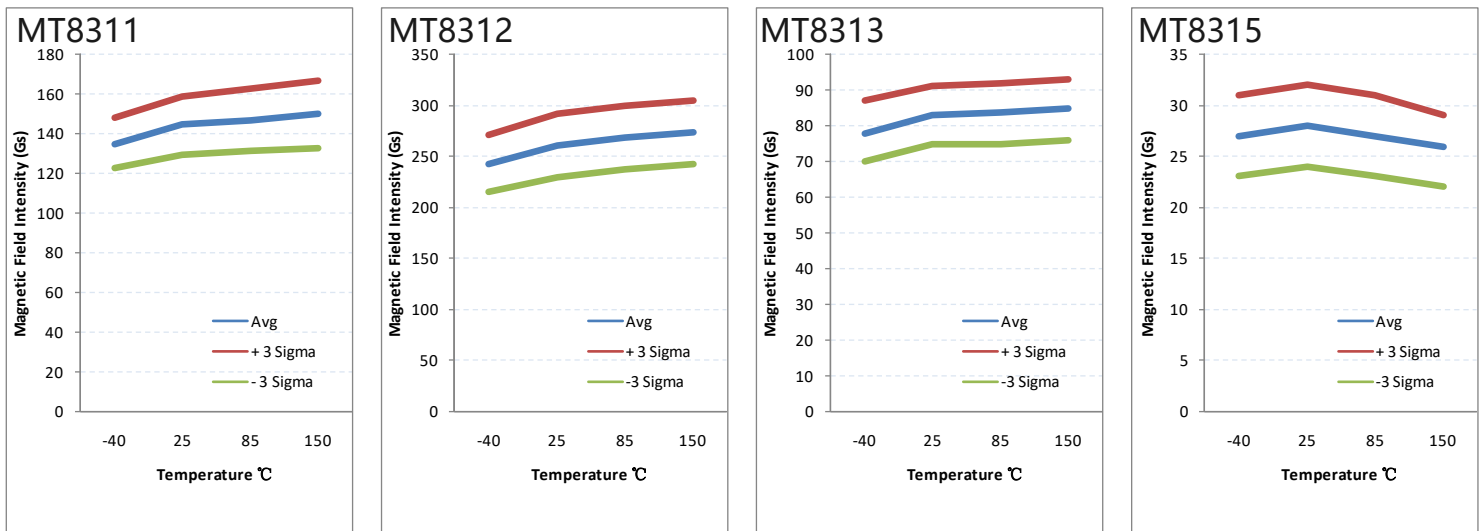


Figure.7 Magnetic Characteristics vs. Temperature (BOP) @ Vcc=5V

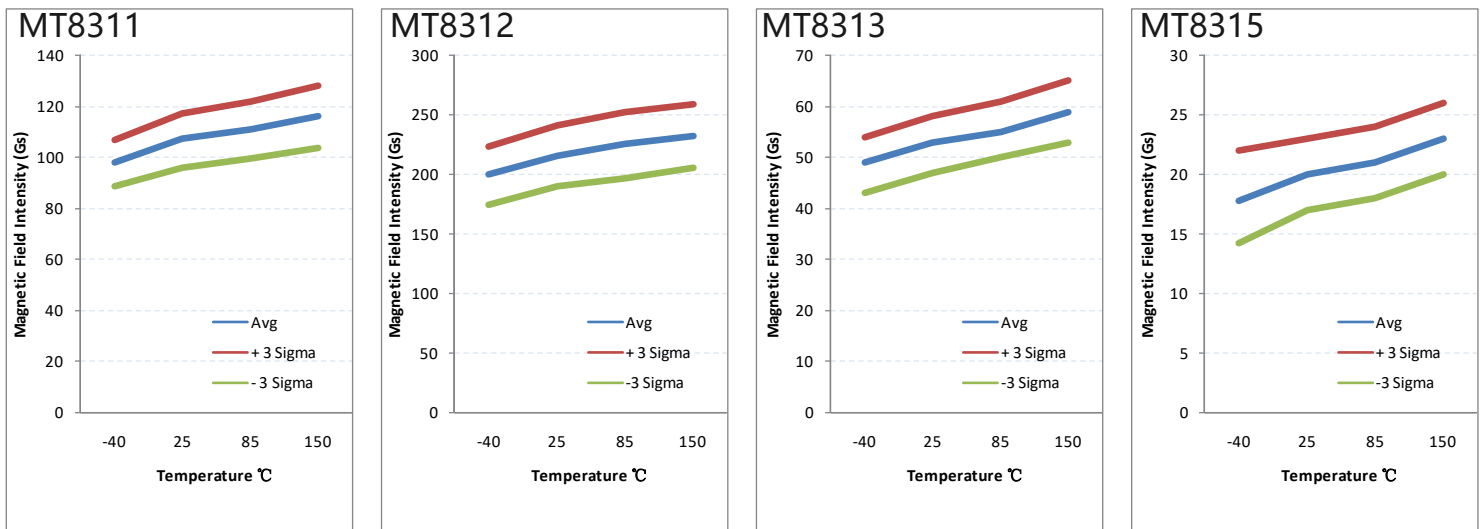


Figure.8 Magnetic Characteristics vs. Temperature (BRP) @ Vcc=5V

### 10.5 Characteristic Performance (Continued)

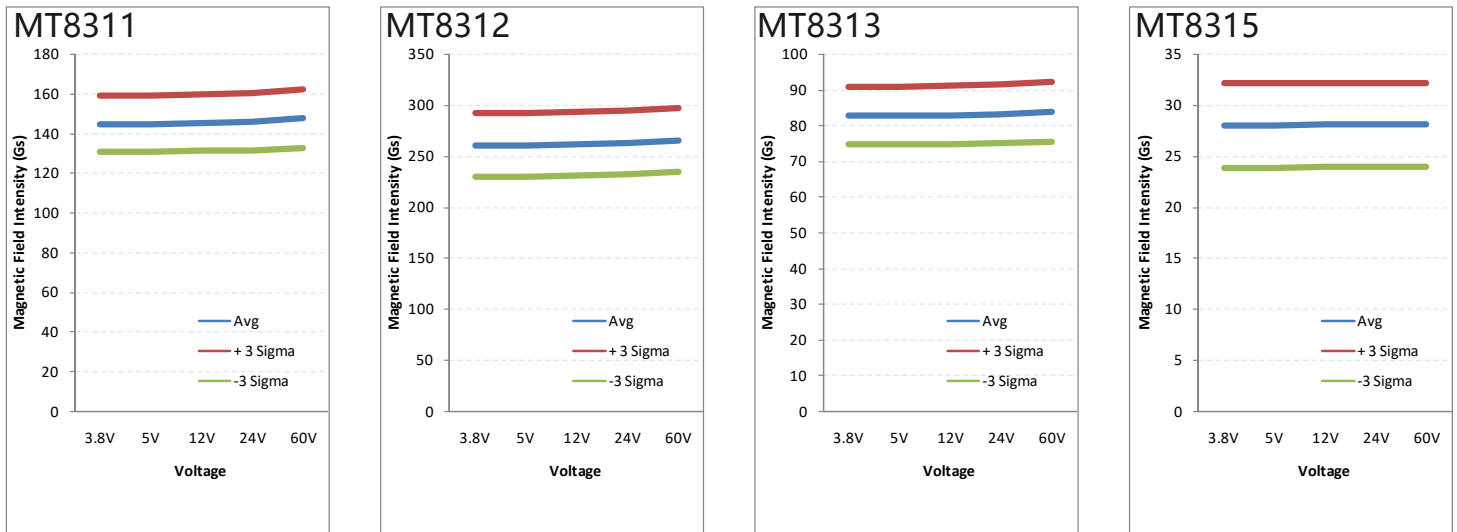


Figure.9 Magnetic Characteristics vs. Voltage (BOP) @ Temperature=25°C

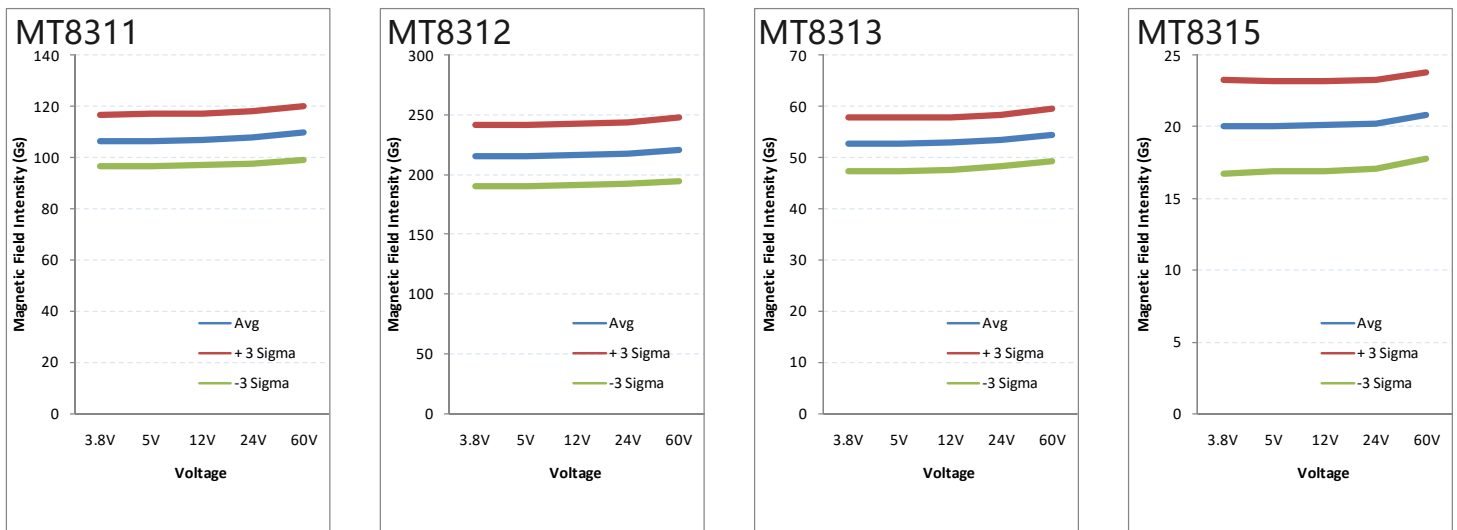


Figure.10 Magnetic Characteristics vs. Voltage (BRP) @ Temperature=25°C

### 10.6 Typical Output Waveform

MT8311A as example

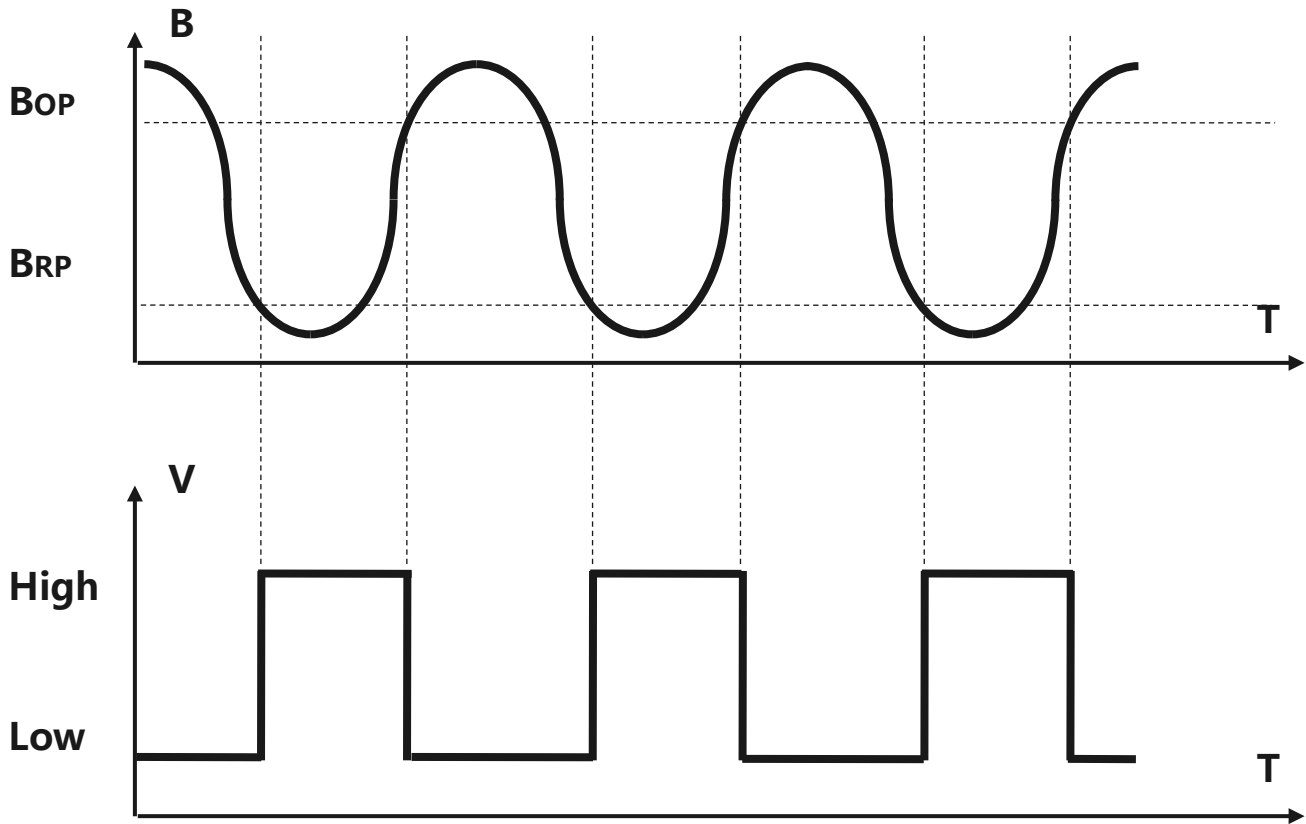


Figure.11 Digital Output vs. Magnetic Flux Density

### 11 Typical Application Circuit

MT8311AT as example

Note: Recommended value for  $R_L$  is 1KOhms to 10KOhms

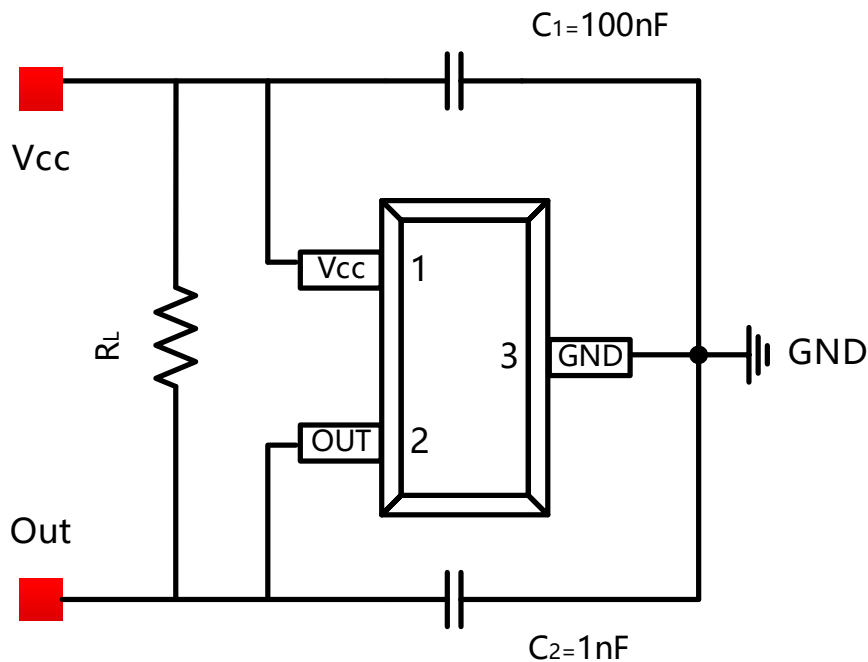


Figure.12 Typical Application Circuit



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

### 12.1 SOT-23 Package Information

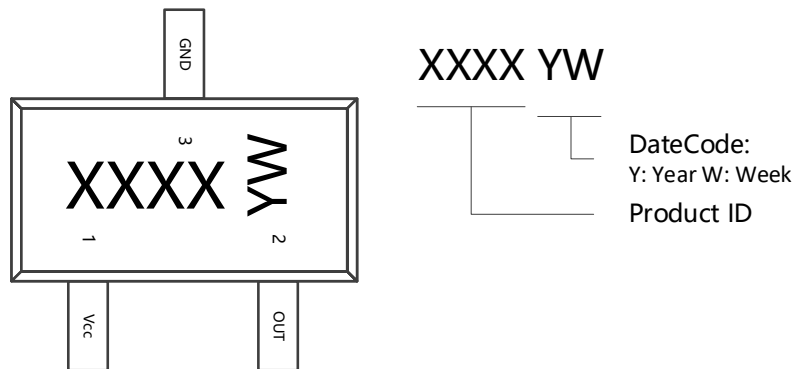


Figure.13 SOT-23 Chip Marking Spec

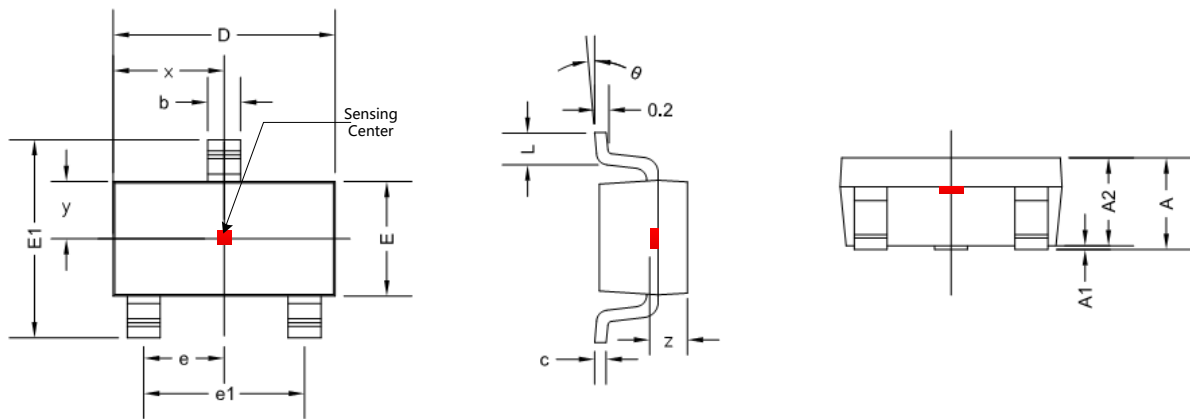


Figure.14 SOT-23 Package Drawing

| 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 |
| $\theta$ | 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

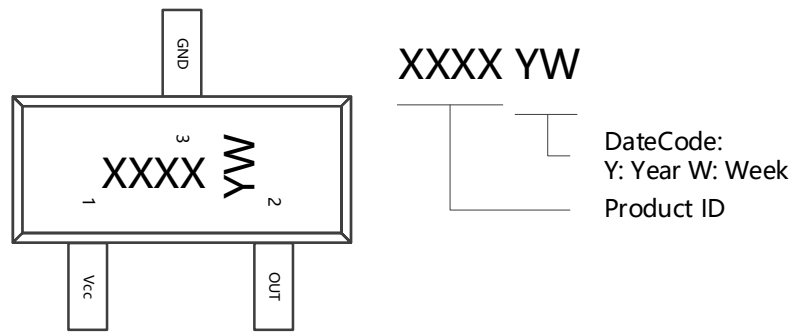


Figure.15 SOT-23 (Thin Outline) Chip Marking Spec

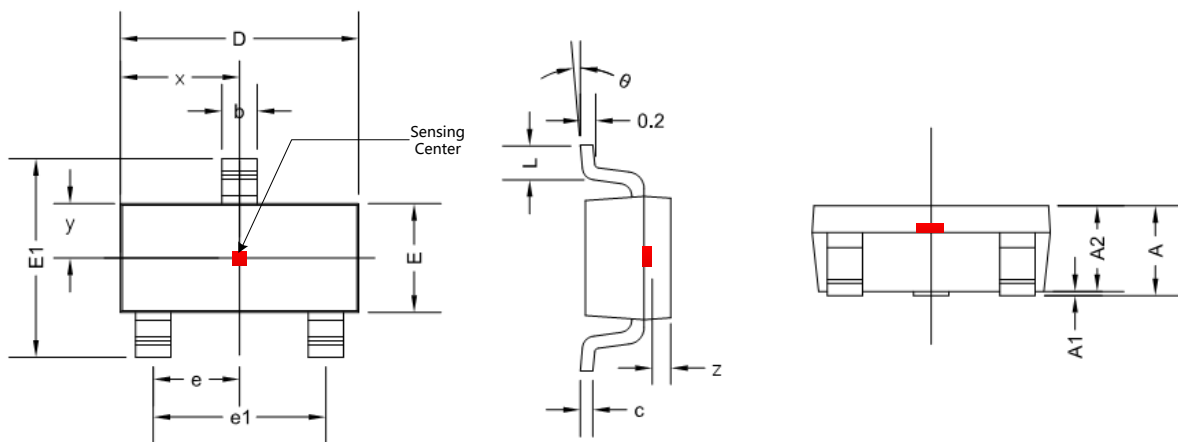


Figure.16 SOT-23 (Thin Outline) Package Drawing

| 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 |
| $\theta$ | 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

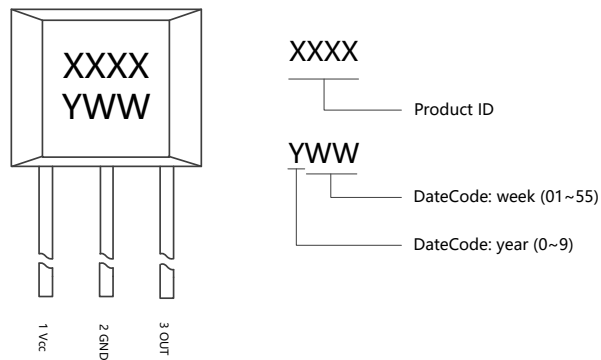


Figure.17 Flat TO-92 Chip Marking Spec

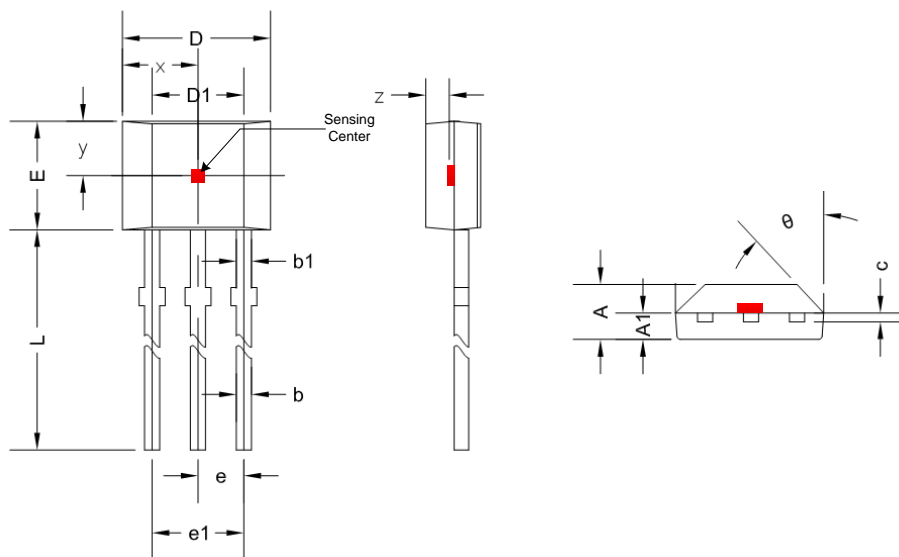


Figure.18 Flat TO-92 Package Drawing

| 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 |
| $\theta$ | 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)

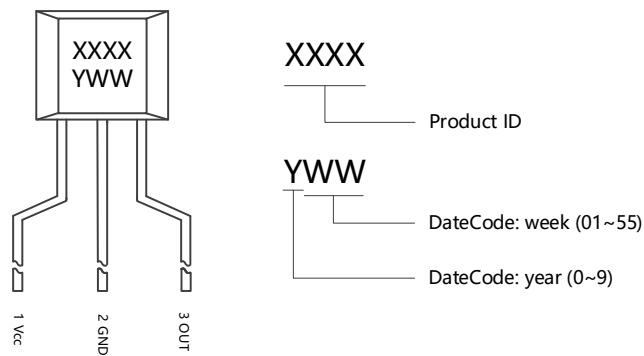


Figure.19 Flat TO-92 (Radial Lead) Chip Marking Spec

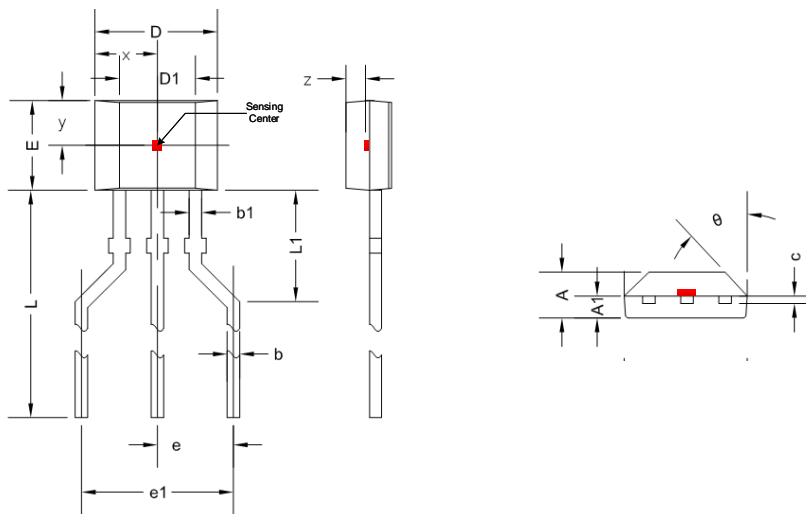


Figure.20 Flat TO-92 (Radial Lead) Package Drawing

| Symbol | Dimensions in Millimeters |       | Dimensions in Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min                       | Max   | Min                  | Max   |
| A      | 1.420                     | 1.620 | 0.056                | 0.064 |
| A1     | 0.660                     | 0.910 | 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      | 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            |       |

### 12.5 SOT-89-3L Package Information

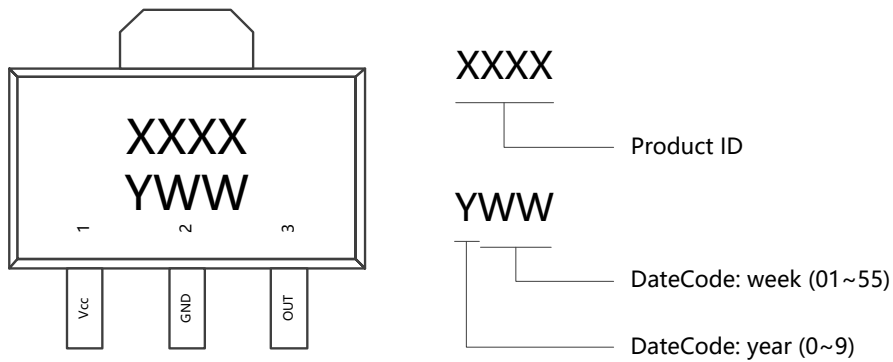


Figure.21 SOT-89-3L Chip Marking Spec

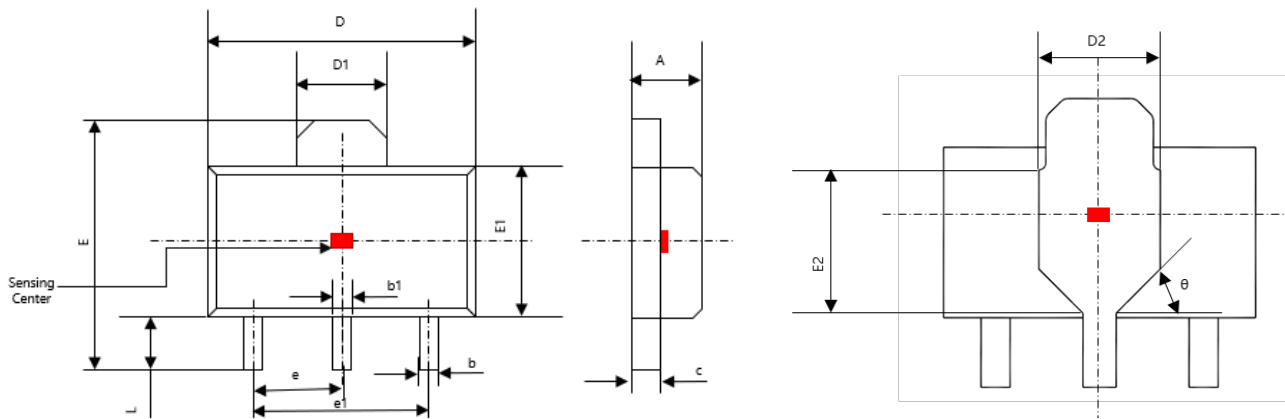


Figure.22 SOT-89-3L Package Drawing

| Symbol | Dimensions in Millimeters |       | Dimensions in Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min                       | Max   | Min                  | Max   |
| A      | 1.400                     | 1.600 | 0.055                | 0.063 |
| b      | 0.320                     | 0.520 | 0.013                | 0.020 |
| b1     | 0.380                     | 0.580 | 0.015                | 0.023 |
| c      | 0.350                     | 0.440 | 0.014                | 0.017 |
| D      | 4.400                     | 4.600 | 0.173                | 0.181 |
| D1     | 1.550 REF                 |       | 0.061 REF            |       |
| D2     | 1.750 REF                 |       | 0.069 REF            |       |
| E      | 3.940                     | 4.250 | 0.155                | 0.167 |
| E1     | 2.300                     | 2.600 | 0.091                | 0.102 |
| E2     | 1.900 REF                 |       | 0.060 REF            |       |
| e      | 1.500 TYP                 |       | 0.060 TYP            |       |
| e1     | 3.000 TYP                 |       | 0.118 TYP            |       |
| L      | 0.900                     | 1.200 | 0.035                | 0.047 |
| θ      | 45°                       |       | 45°                  |       |

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