# MT816X

## Latch, Hall-Effect Magnetic Position Sensor

**MagnTek**

## 1  Product Description

The MT816X 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 ±5.5KV (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
- Package Option:
  Flat TO-92 / SOT-23 / SOT-23 (Thin Outline) / WLCSP
- Magnetic Sensitivity Option:
  MT8161  ($B_{OP}$=20Gs, $B_{RP}$=-20Gs)
  MT8162  ($B_{OP}$=60Gs, $B_{RP}$=-60Gs)
- Open-Drain Output
- -27V Reversed Power Supply Protection
- Output Limiting Current Protection
- RoHS Compliant: (EU)2015/863

## 3  Product Overview of MT816X

| Part No. | Description |
|---|---|
| MT816XA | Flat TO-92, bulk packaging (1000pcs/bag) |
| MT816XAT | SOT-23, tape & reel (3000pcs/bag) |
| MT816XET | SOT-23 (thin outline), tape & reel (3000pcs/bag) |
| MT816XCSP | WLCSP，tape & reel (3000pcs/bag) |
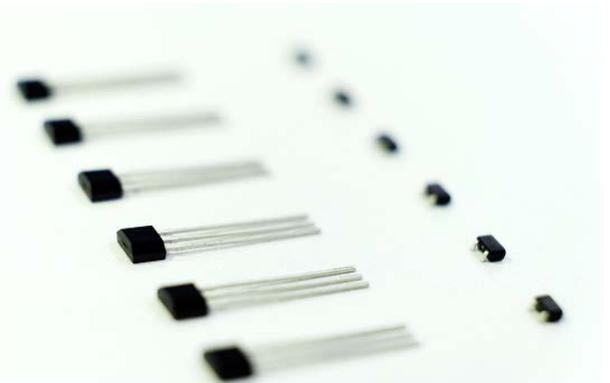
## 4  Applications

- Home appliances
- Industrial
- Speed Detection
- 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 |
| WLCSP | A1 | B2 | B1 |
| Description | Power | Output Open-Drain | Ground |
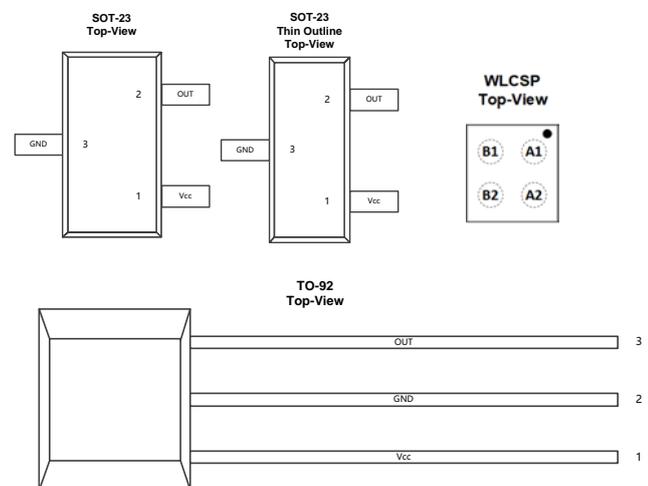


Figure.1    Pin Configuration & Functions

# Table of Contents

# Reversion History

| 1 | Originally Version | |
|---|---|---|
| 2 | 1.1 Version | Update $B_{OP}$ & $B_{RP}$ |
| | | Update Copy Rights and Disclaimer |
| 3 | 1.2 Version | Update the marking spec of SOT-23 & SOT-23 (Thin Outline) |
| 4 | 1.3 Version | Update MT8161CSP |
| 5 | 1.4 Version | Update the Logo of MagnTek |
| 6 | 1.5 Version | Update MT8162 series |

## 6 Definition of Switching Function

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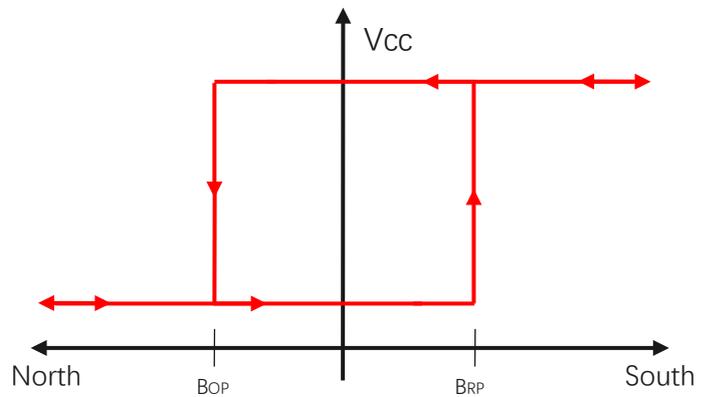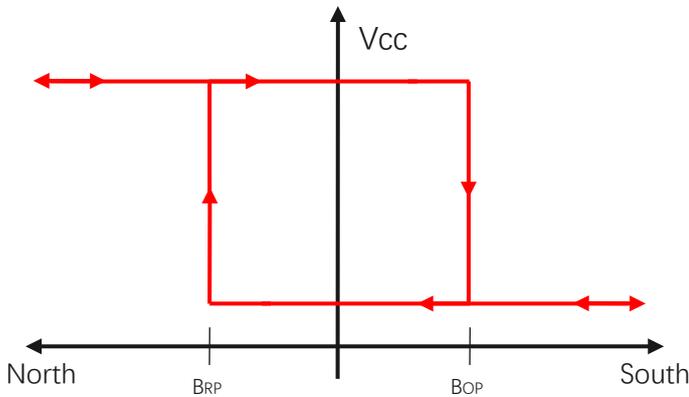


| Figure.2 | Switching Function of Flat TO-92 & SOT-23 (Thin Outline) |

| Figure.3 | Switching Function of SOT-23 & WLCSP |

## 7 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.

## 8 Feature Description

The MT816X device is sensitive to the magnetic field component that is perpendicular to the top of the package



$V_{OUT}$ = Low

$V_{OUT}$= High
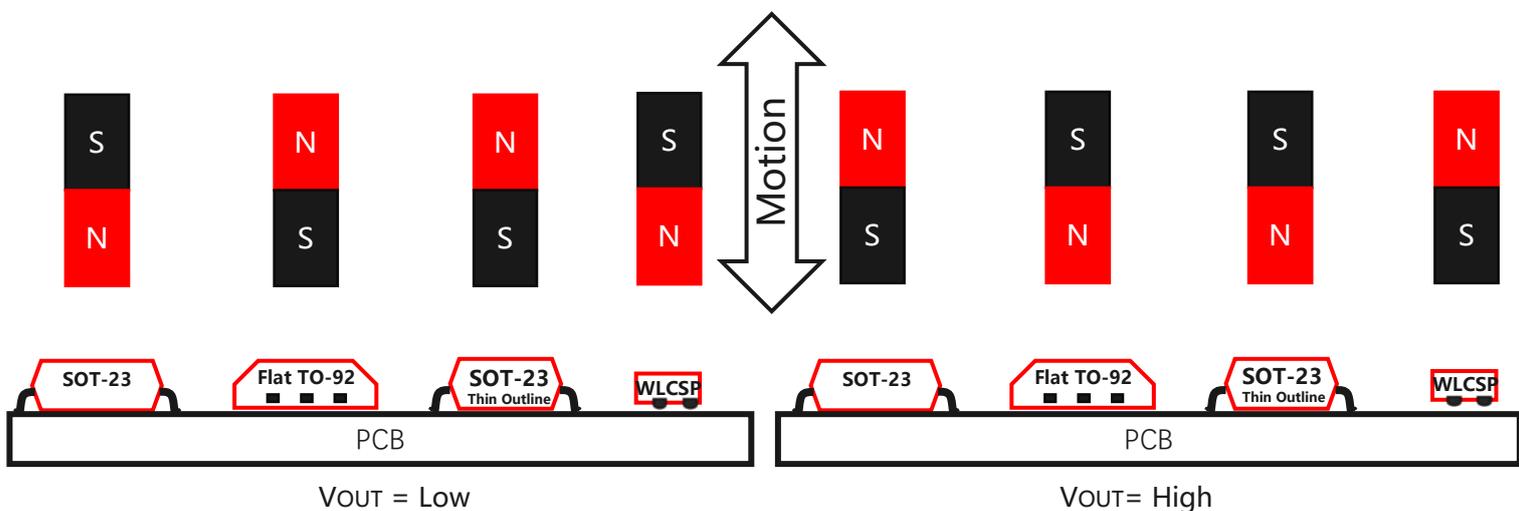
| Figure.4 | Flux Direction Polarity |

## 9 Functional Block Diagram



Vcc

GND

Out

ESD
Reference
Regulator
Dynamic Offset Cancelation
Limiting Current Protection
Hall Plate
ITA
COMP
Output Driver
ESD
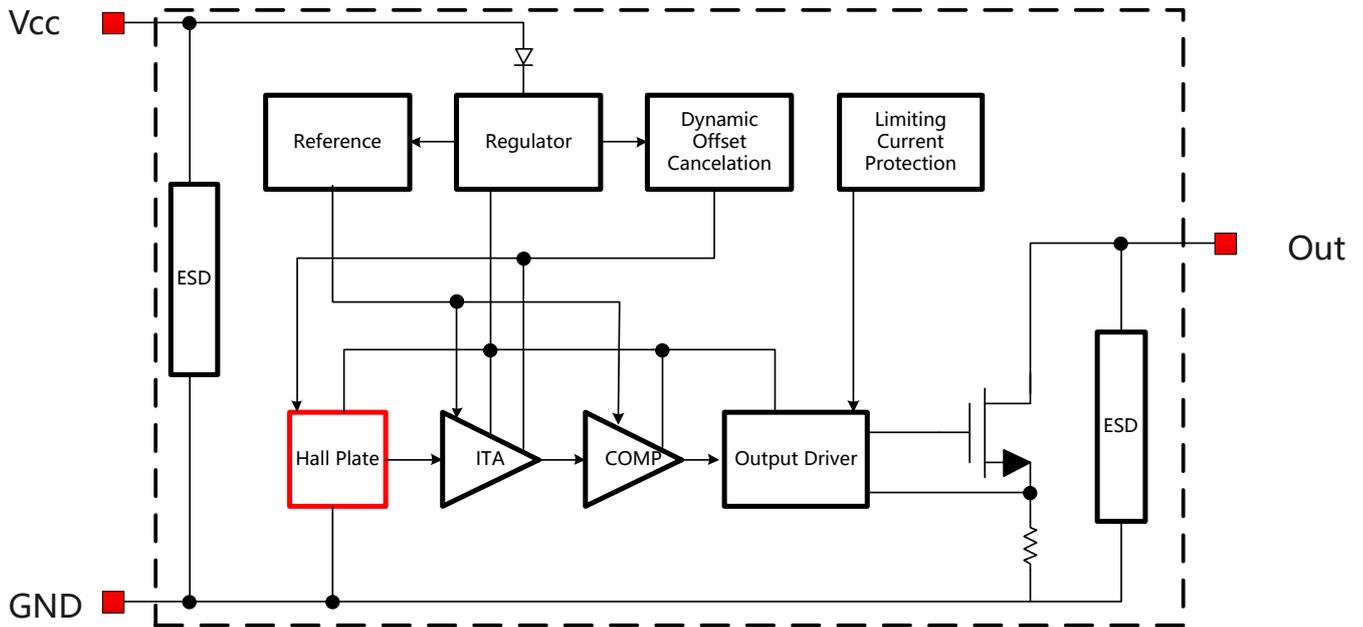
Figure.5    Functional Block Diagram

## 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 | $B<B_{OP}$ | - | 3.50 | 6 | 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 TO-92 | | - | 230 | - | ℃/W |

## 10.3 Magnetic Characteristics

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

| Part No. | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| MT8161 Series | $B_{OP}$, $T_A$ =25℃ | 10 | 20 | 30 | Gs |
| | $B_{RP}$, $T_A$ =25℃ | -30 | -20 | -10 | Gs |
| | $B_{HYST}$, $T_A$ =25℃ | 20 | 40 | 60 | Gs |
| MT8162 Series | $B_{OP}$, $T_A$ =25℃ | 40 | 60 | 80 | Gs |
| | $B_{RP}$, $T_A$ =25℃ | -80 | -60 | -40 | Gs |
| | $B_{HYST}$, $T_A$ =25℃ | 80 | 120 | 160 | Gs |

## 10.4 ESD Ratings

| Symbol | | Reference | Values | Unit |
|---|---|---|---|---|
| $V_{ESD}$ | Human-body model (HBM) | AEC-Q100-002 | ±5500 | V |
| | Charged-device model (CDM) | AEC-Q100-011 | ±1000 | V |

## 10.5 Characteristic Performance

At V$_{CC}$=5V
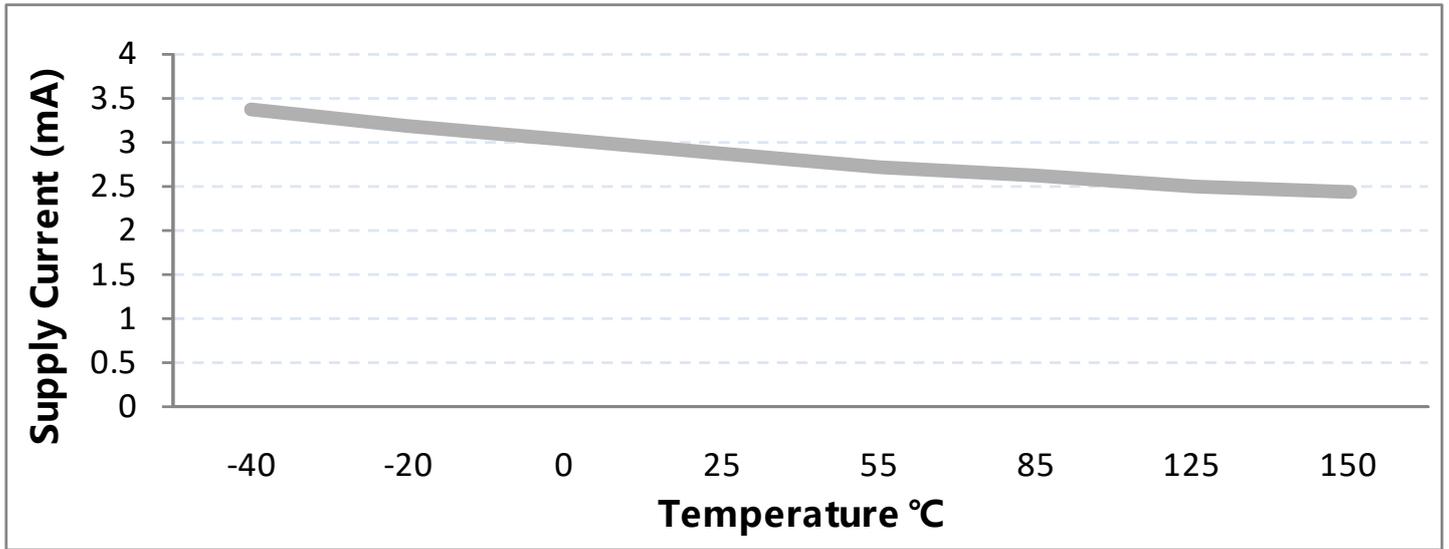
Figure.6    Supply Current vs. Temperature
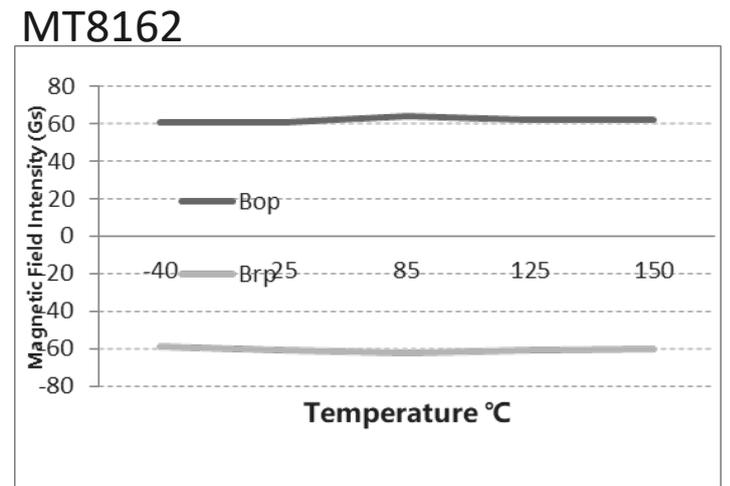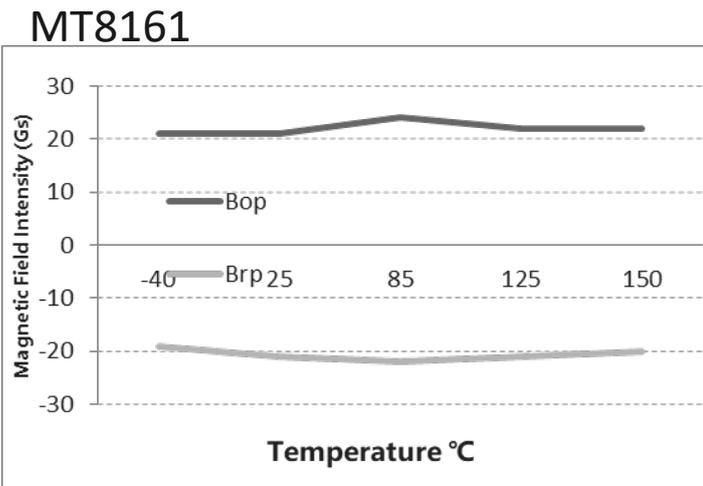
### MT8161

### MT8162



Figure.7    Magnetic Characteristics vs. Temperature (B$_{OP}$ & B$_{RP}$)
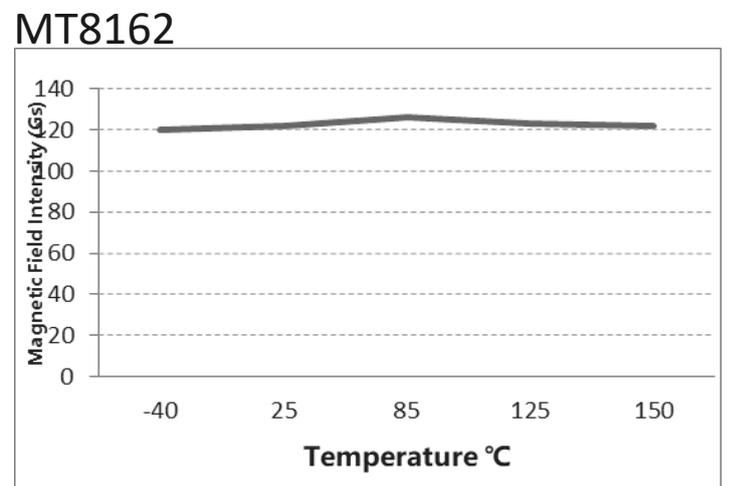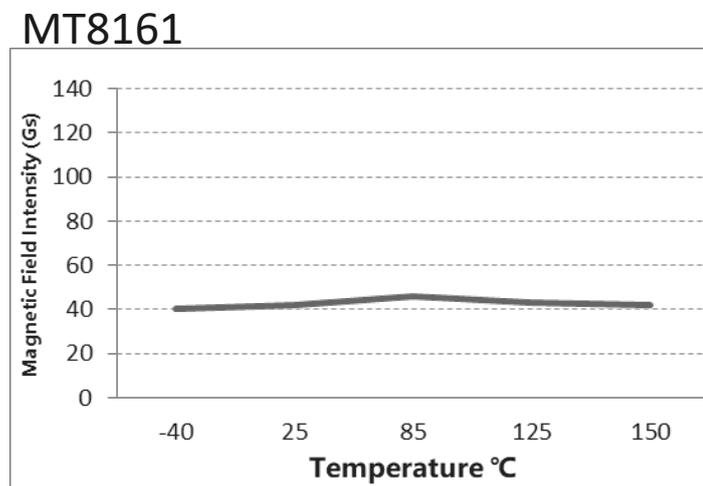
### MT8161

### MT8162



Figure.8    Magnetic Characteristics vs. Temperature (B$_{HYST}$)

## 10.6 Typical Output Waveform

MT8161A as example
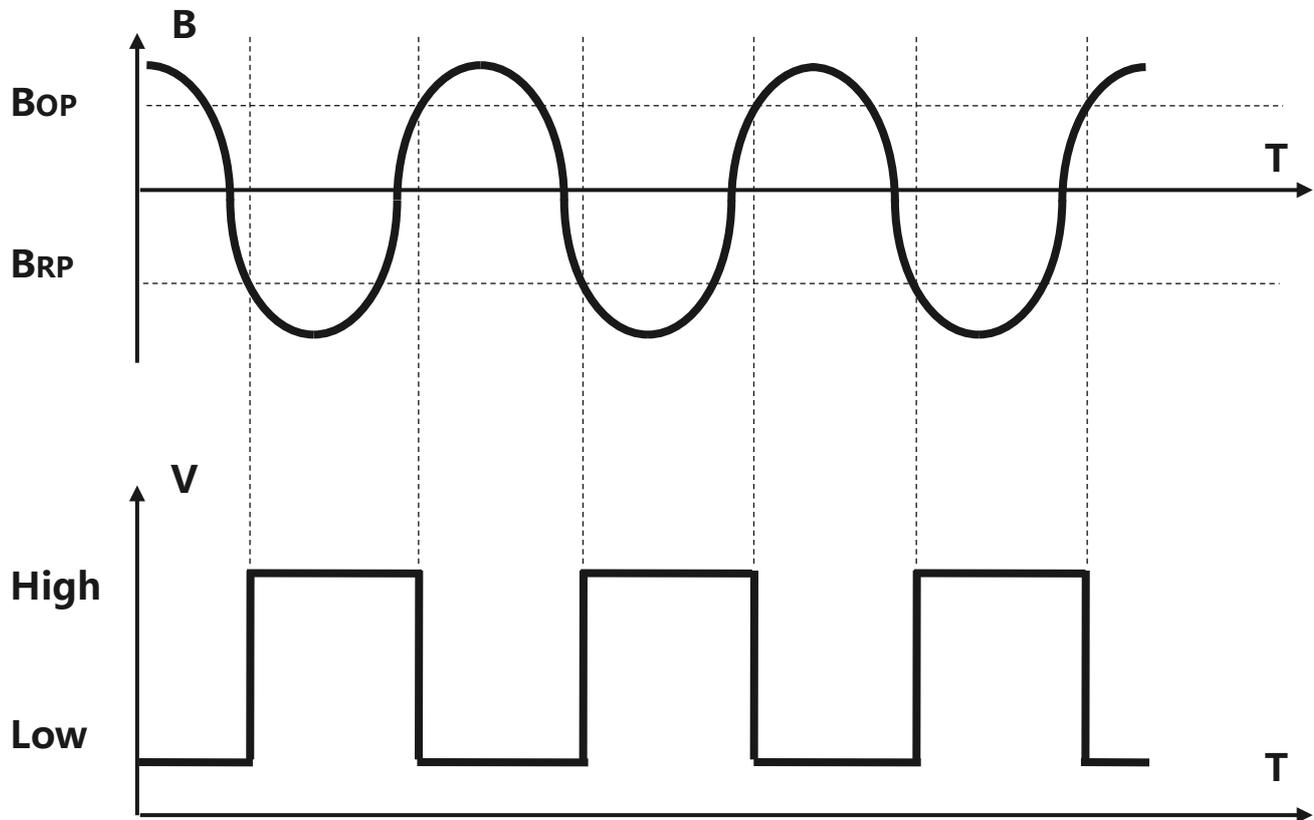


Digital Output vs. Magnetic Flux Density

## 11 Typical Application Circuit

MT8161AT as example
Note: Recommended value for $R_L$ is 1KOhms to 10KOhms
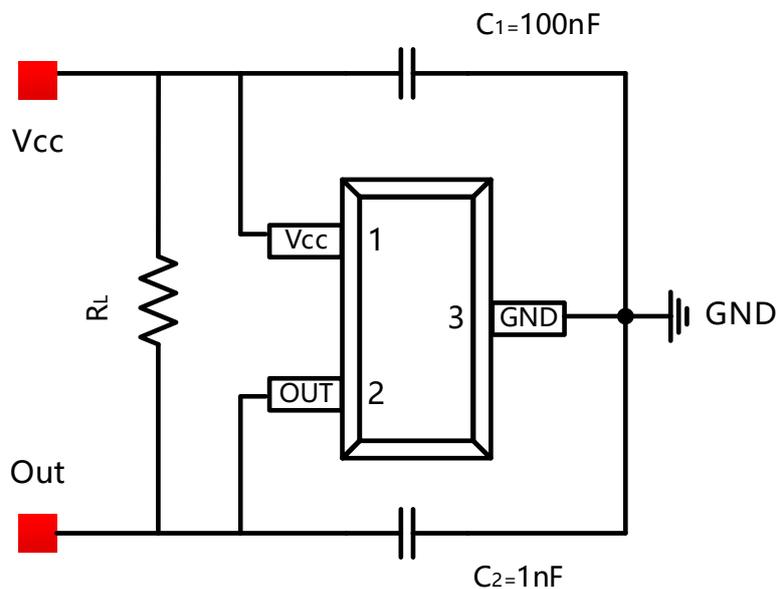


Typical Application Circuit

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

## 12.1 SOT-23 Package Information
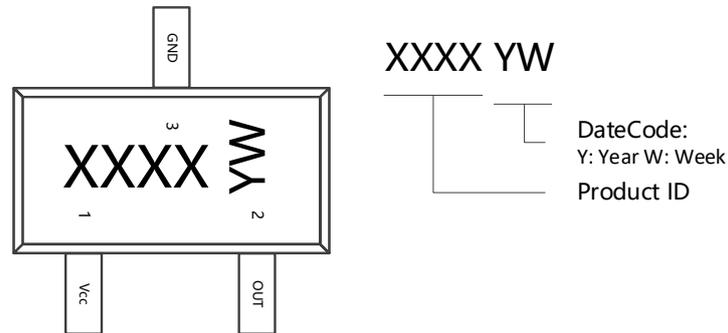


| Figure.11 | SOT-23 Chip Marking Spec |



| Figure.12 | SOT-23 Package Drawing |

| Symbol | Dimensions in Millimeters | | Dimensions in Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 1.050 | 1.300 | 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 | 1.460 TYP | | 0.057 TYP | |
| y | 0.800 TYP | | 0.032 TYP | |
| z | 0.600 TYP | | 0.024 TYP | |
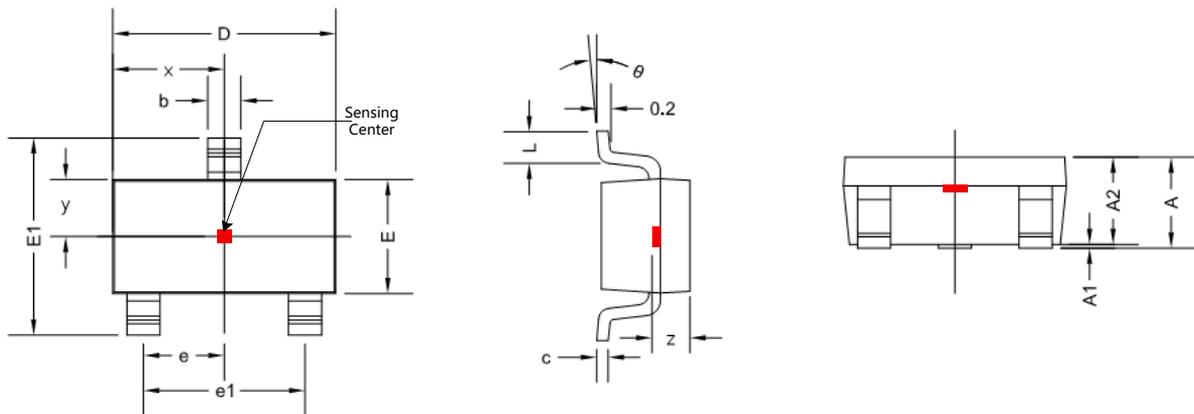
## 12.2 SOT-23 (Thin Outline) Package Information



XXXX YW

DateCode:
Y: Year W: Week

Product ID
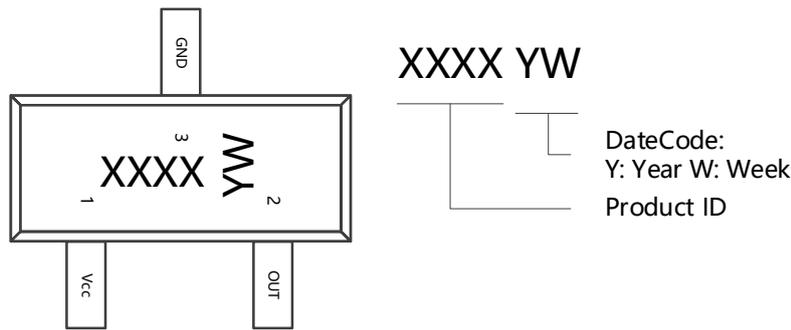
SOT-23 (Thin Outline) Chip Marking Spec
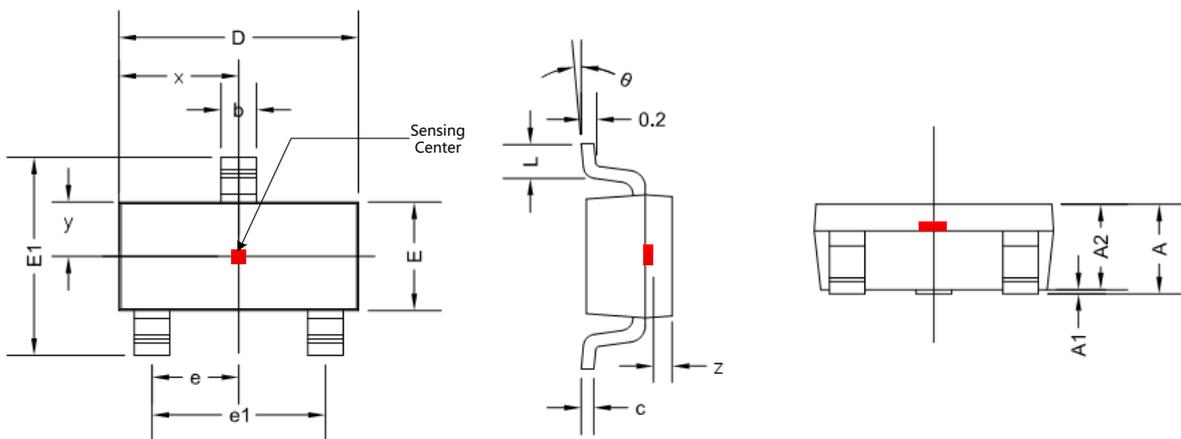
SOT-23 (Thin Outline) Package Drawing

| 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 | 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
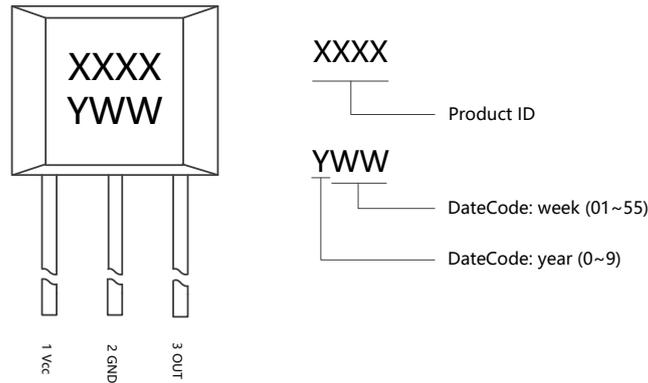
Figure.15    Flat TO-92 Chip Marking Spec
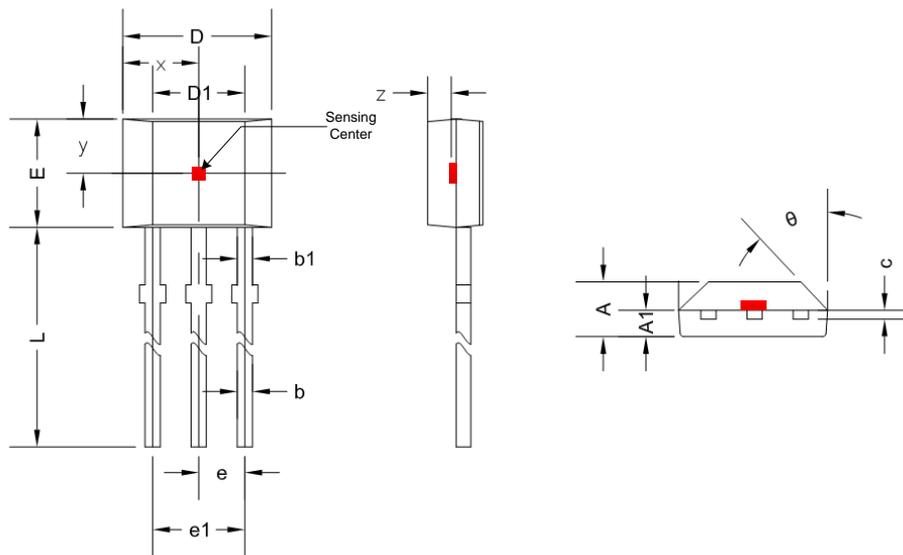


Figure.16    Flat TO-92 Package Drawing

| Symbol | Dimensions in Millimeters | | Dimensions in Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 1.420 | 1.620 | 0.056 | 0.064 |
| A1 | 0.660 | 0.910 | 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 | 2.025 TYP | | 0.080 TYP | |
| y | 1.545 TYP | | 0.061 TYP | |
| z | 0.500 TYP | | 0.020 TYP | |

## 12.4 WLCSP Package Information
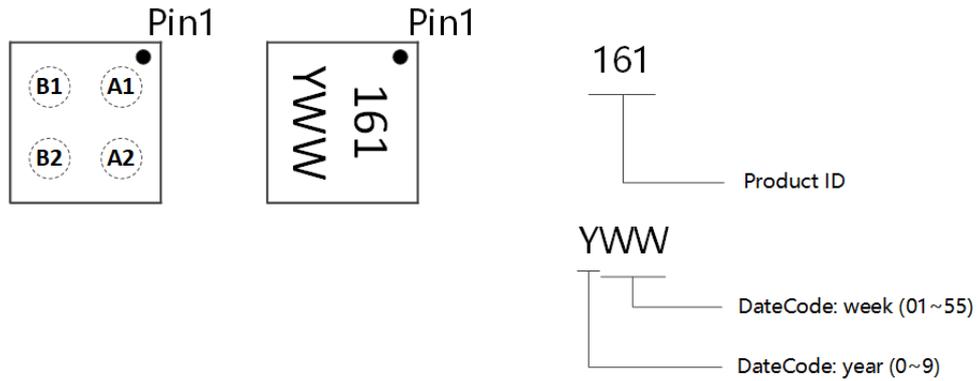


Figure.17    WLCSP Chip Marking Spec  （Top View）
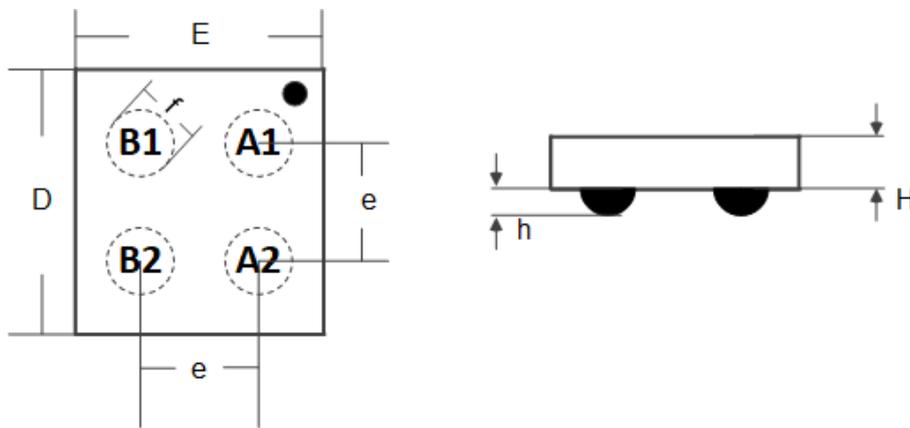


Figure18    WLCSP Package Drawing

| Symbol | Dimensions in Millimeters | | Dimensions in Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| E | 0.745 | 0.795 | 0.030 | 0.032 |
| D | 0.775 | 0.825 | 0.031 | 0.033 |
| e | 0.400 TYP | | 0.016 TYP | |
| f | 0.200 TYP | | 0.008 TYP | |
| H | 0.312 | 0.368 | 0.012 | 0.015 |
| h | 0.060 TYP | | 0.002 TYP | |

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