# MT4409A-EN

## Latch, Hall-Effect Magnetic Position Sensor

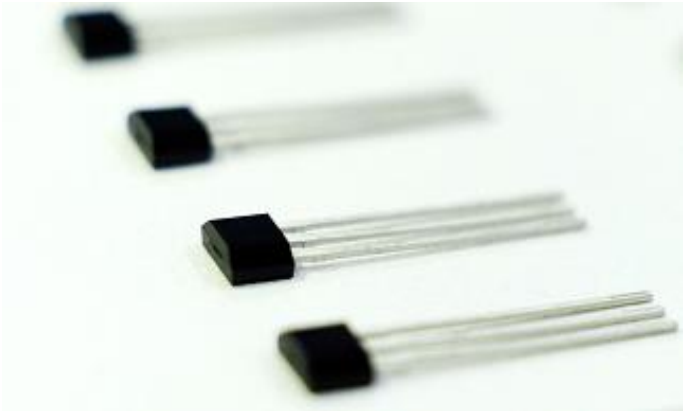
## 1 Product Description

The MT4409A-EN 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 Feature

- BCD Technology
- Latch Switch
- 2.8~24V Operating Vcc Range
- -40℃~150℃ Operating Temperature
- Package Option:
  Flat TO-92
- Magnetic Sensitivity Option:
  $B_{OP}$=45Gs, $B_{RP}$=-45Gs
- Open-Drain Output
- -27V Reversed Power Supply Protection
- Output Limiting Current Protection
- RoHS Compliant: (EU)2015/863



## 3 Product Overview of MT4409A-EN

| Part No. | Description |
|---|---|
| MT4409A-EN | Flat TO-92, bulk packaging (1000pcs/bag) |

## 4 Applications

- Home appliances
- Industrial
- Position Detection
- Proximity Switch

## 5. Pin Configuration and Functions

| | Vcc | GND | Out |
|---|---|---|---|
| Flat TO-92 | 1 | 2 | 3 |
| Description | Power | Ground | Output<br>Open-Drain |

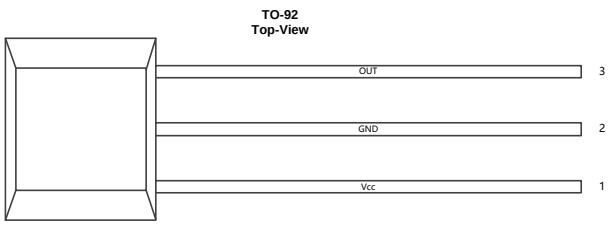



Figure.1 Pin Configuration & Functions

# Table of Contents



# Reversion History

| | | |
|---|---|---|
| 1 | Originally Version | |
| 2 | 1.1 Version | Update format |

## 6 Definition of Switching Function

Figure.2 shows the device functionality and hysteresis

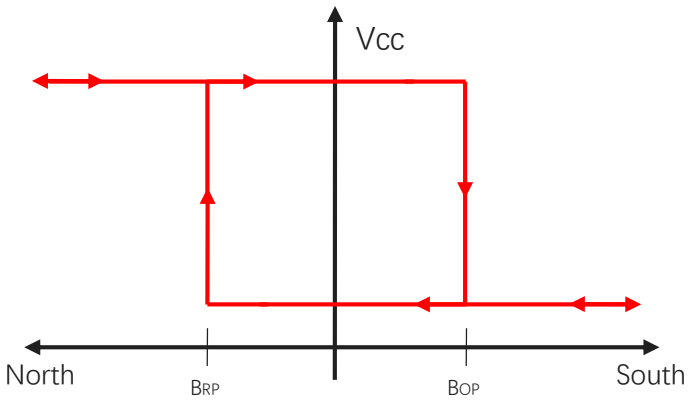



Figure.2 Switching Function

## 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 MT4409A-EN device is sensitive to the magnetic field component that is perpendicular to the top of the package

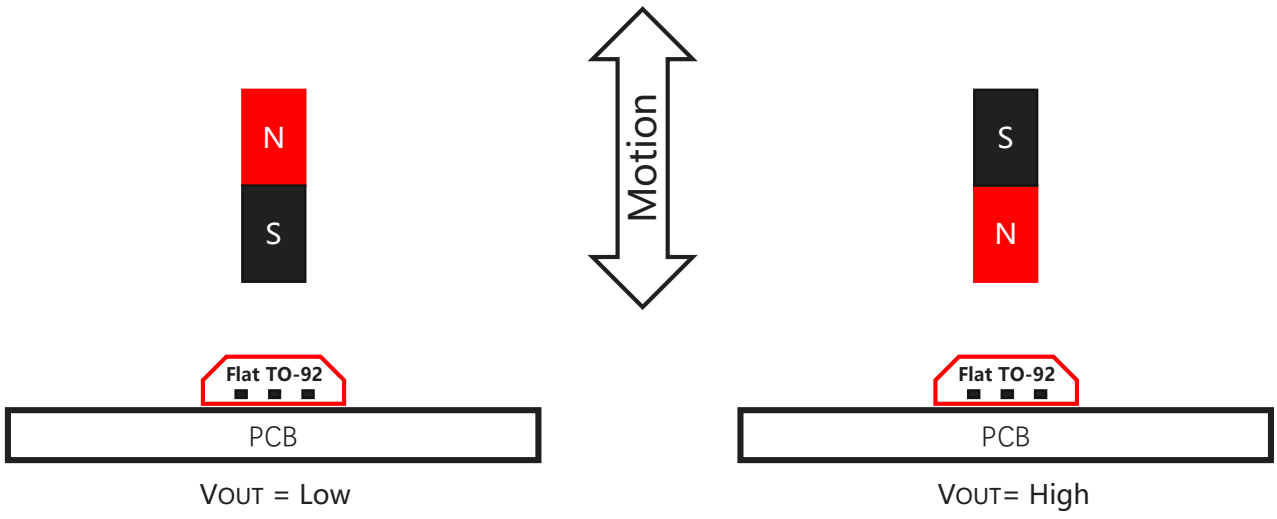



Figure.3 Flux Direction Polarity

## 9 Functional Block Diagram

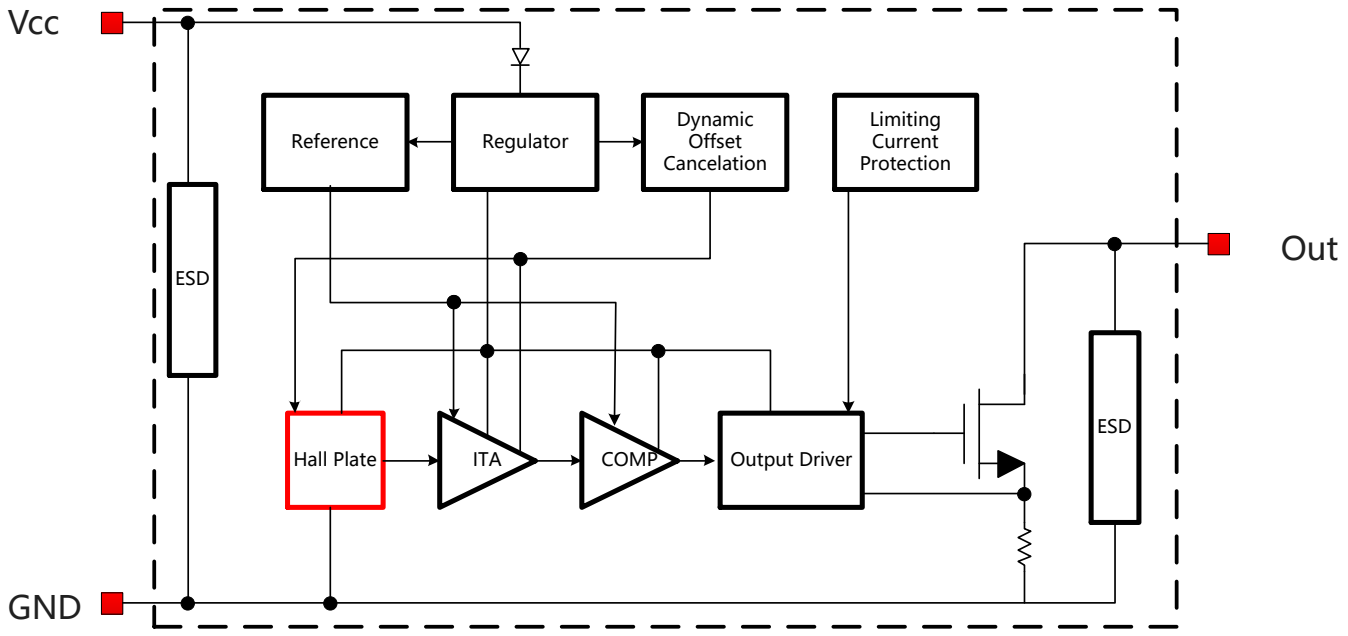



Figure.4 Functional Block Diagram

## 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<$B_{OP}$ | - | 4.25 | 7 | 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 Fail 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 |
| $T_{Rep}$ | Response Time | | - | 2.5 | - | us |
| $R_{TH}$ | 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 |
|---|---|---|---|---|---|
| MT4409A-EN | $B_{OP}$, $T_A$ =25℃ | 15 | 45 | 75 | Gs |
| | $B_{RP}$, $T_A$ =25℃ | -75 | -45 | -15 | Gs |
| | $B_{HYST}$, $T_A$ =25℃ | 30 | 90 | 150 | 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

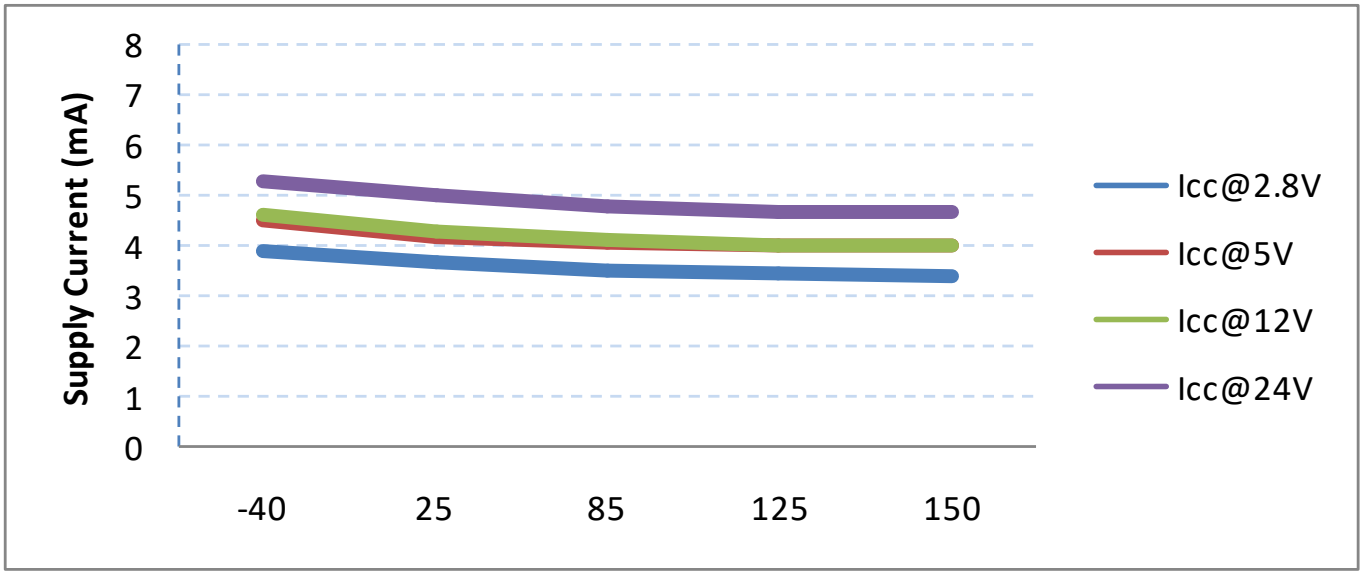



Figure.5 Supply Current vs. Vcc

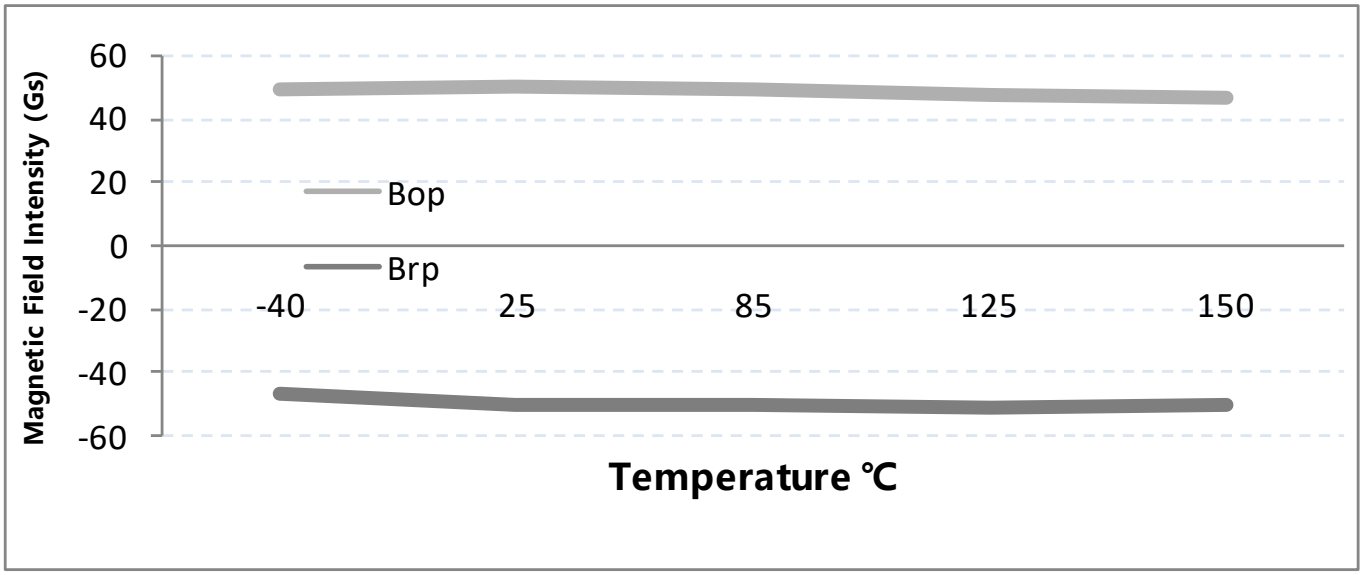



Figure.6 Magnetic Characteristics vs. Temperature (BOP & BRP)

Vcc=5V

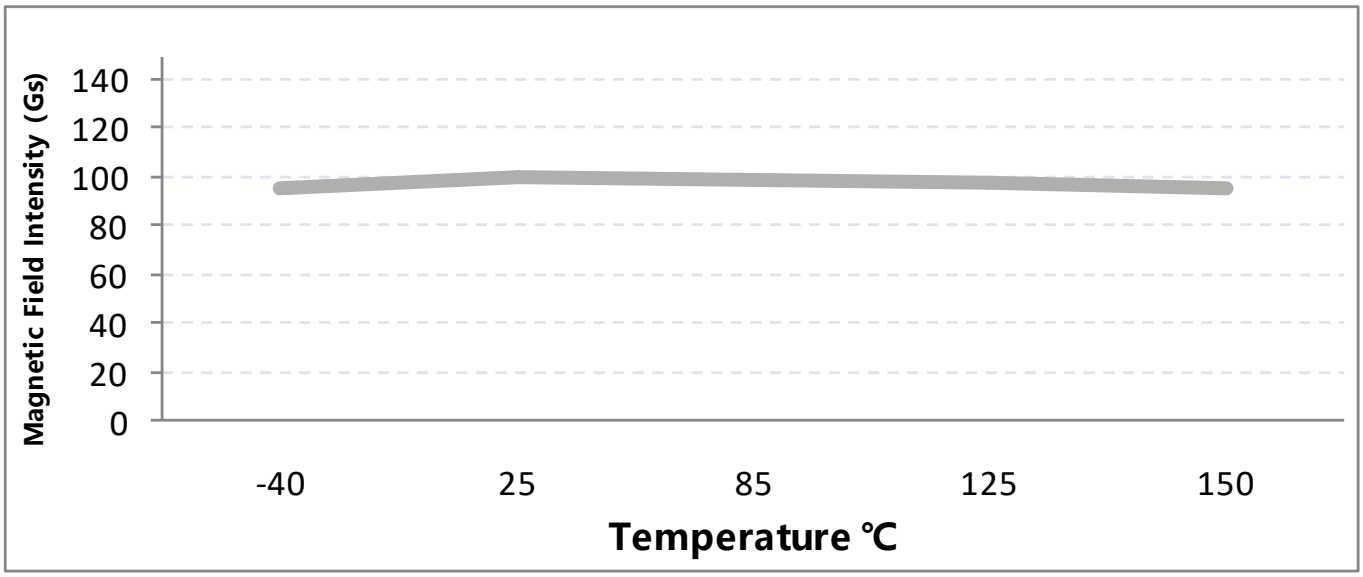



Figure.7 Magnetic Characteristics vs. Temperature (BHYST)

Vcc=5V

### 10.6 Typical Output Waveform

MT4409A-EN as example

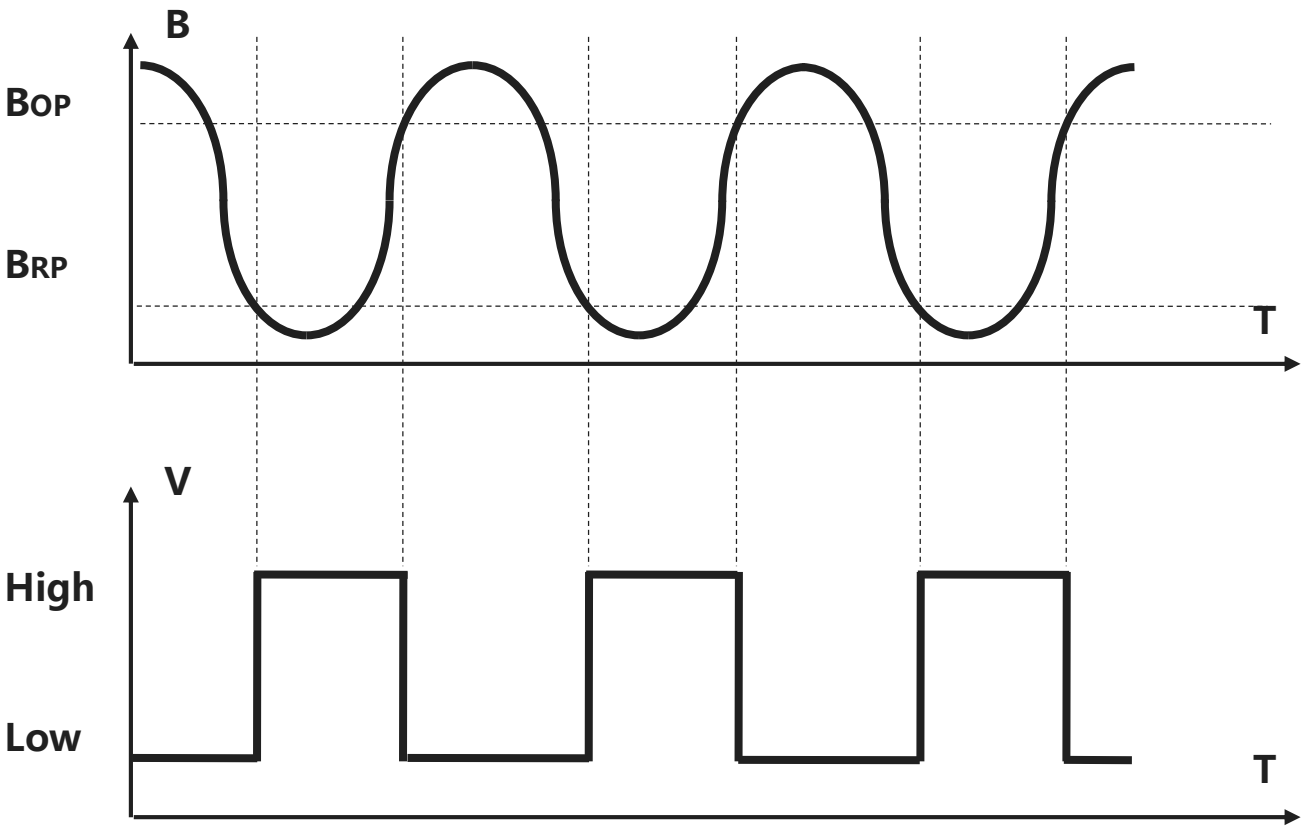



Figure.8 Digital Output vs. Magnetic Flux Density

## 11 Typical Application Circuit

MT4409A-EN as example
Note: Recommended value for $R_L$ is 1KOhms to 10KOhms

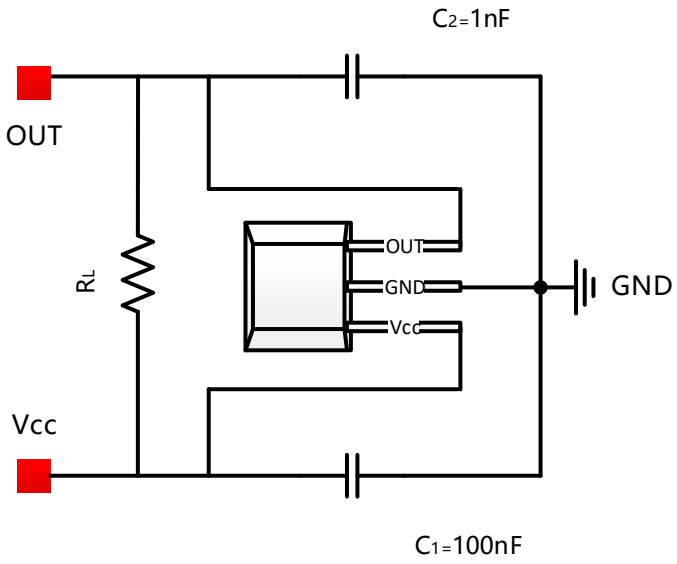



Figure.9 Typical Application Circuit

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

### 12.1 Flat TO-92 Package Information

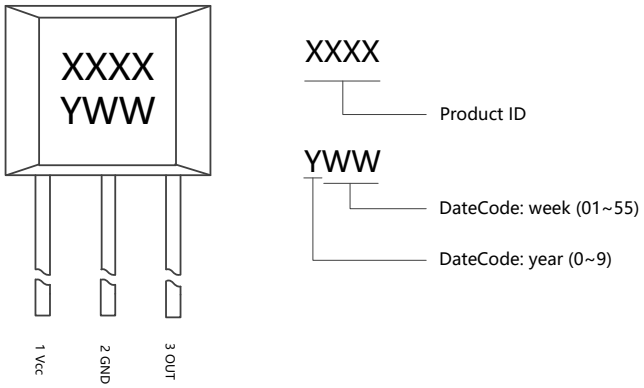



Figure.10 Flat TO-92 Chip Marking Spec

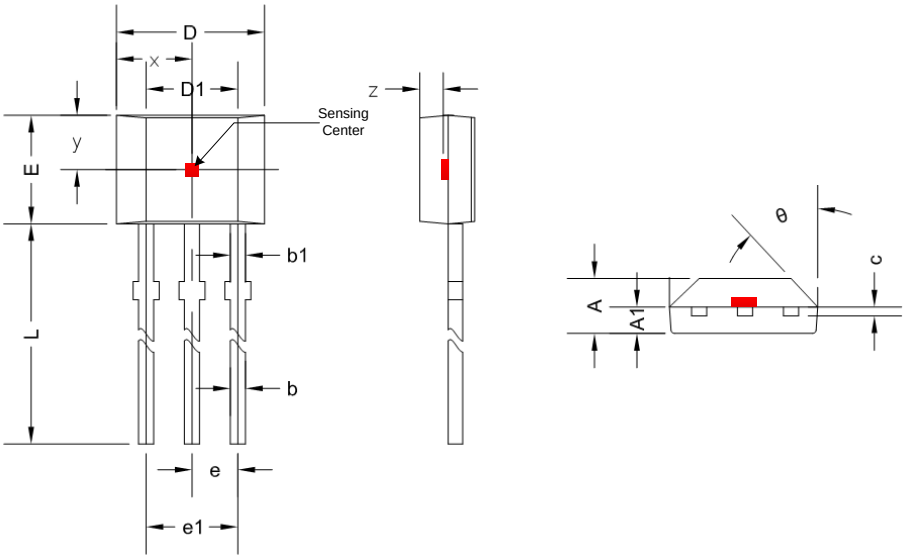



Figure.11 Flat TO-92 Package Drawing

| 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 | |

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