MH493, a linear Hall-effect sensor, is composed of Hall sensor, linear amplifier and Totem-Pole output stage. It features low noise output, which makes it unnecessary to use external filtering. It also can provide increased temperature stability and accuracy. The linear Hall sensor has a wide operating temperature range of -40°C to +125°C, appropriate for commercial, consumer, and industrial environments.

The high sensitivity of Hall-effect sensor accurately tracks extremely weak changes in magnetic flux density. The linear sourcing output voltage is set by the supply voltage and in proportion of vary of the magnetic flux density. Typical operation current is 2.5 mA and operating voltage range is 2.8 volts to 6.0 volts. Trim version is available for an ultra low offset products.

The three package styles available provide magnetically optimized solutions for most applications. Package types SO is an SOT-23(1.1 mm nominal height), while package UA is a three-lead ultra-mini SIP for through-hole mounting.

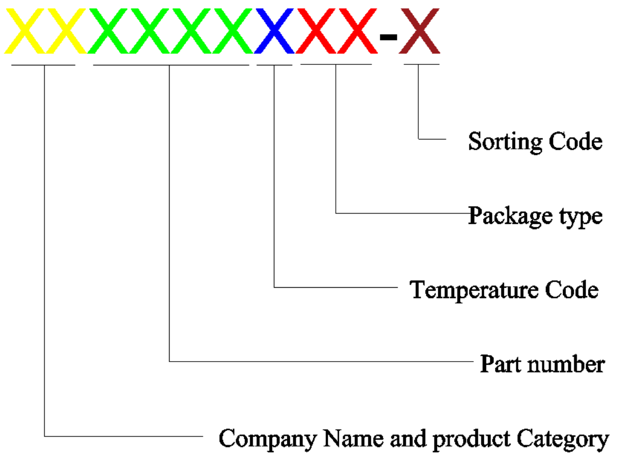
## *Features and Benefits*

- Operating Voltage Range: 2.8V~6.0V
- Power consumption of 3.3mA at 5 $V_{DC}$ for energy efficiency
- Low-Noise Operation
- Linear output for circuit design flexibility
- Totem-Pole for a stable and accurate output
- Responds to either positive or negative gauss
- Magnetically Optimized Package for UA,SQ,SO
- Trim version is precise on offset
- Robust ESD performance
- RoHS compliant 2011/65/EU and Halogen Free

## *Applications*

- Current sensing
- Motor control
- Position sensing
- Magnetic code reading
- Rotary encoder
- Ferrous metal detector
- Vibration sensing
- Liquid level sensing
- Weight sensing

## *Ordering Information*




**Company Name and Product Category**

MH:MST Hall Effect/MP:MST Power IC

**Part number**

181,D182,183,184,185,248,477,D381,D381F,381R,D382…..

If part # is just 3 digits, the forth digit will be omitted.

**Temperature range**

E: 85 °C, I: 105 °C, K: 125 °C, L: 150 °C

**Package type**

UA:TO-92S,VK:TO-92S(4pin),VF:TO-92S(5pin),SO:SOT-23,

SQ:QFN-3,ST:TSOT-23,SN:SOT-553,SF:SOT-89(5pin),

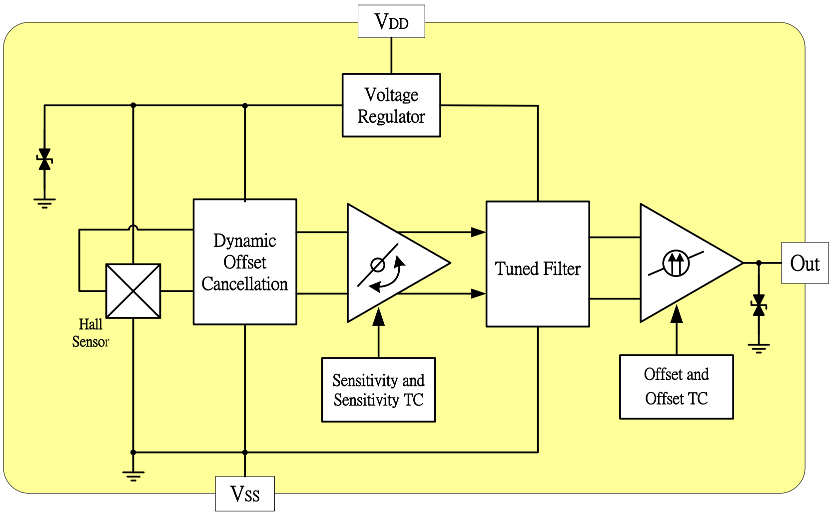
SS:TSOT-26,SD:DFN-6,SG:SOT-89(3pin)

**Sorting**

α,β,Blank…..

| **Part No.** | **Temperature Suffix** | **Package Type** |
|---|---|---|
| MH493IUA-A | I (-40°C to +105°C) | UA (TO92-3L) |
| MH493IUA-B | I (-40°C to +105°C) | UA (TO92-3L) |
| MH493IUA-C | I (-40°C to +105°C) | UA (TO92-3L) |
| MH493IUA-D | I (-40°C to +105°C) | UA (TO92-3L) |
| MH493ISO-A | I (-40°C to +105°C) | SO(SOT-23) |
| MH493ISO-B | I (-40°C to +105°C) | SO(SOT-23) |
| MH493ISO-C | I (-40°C to +105°C) | SO(SOT-23) |
| MH493ISO-D | I (-40°C to +105°C) | SO(SOT-23) |
| MH493IUA-A-T | I (-40°C to +105°C) | UA (TO92-3L) |
| MH493IUA-B-T | I (-40°C to +105°C) | UA (TO92-3L) |
| MH493IUA-C-T | I (-40°C to +105°C) | UA (TO92-3L) |
| MH493IUA-D-T | I (-40°C to +105°C) | UA (TO92-3L) |
| MH493ISO-A-T | I (-40°C to +105°C) | SO(SOT-23) |
| MH493ISO-B-T | I (-40°C to +105°C) | SO(SOT-23) |
| MH493ISO-C-T | I (-40°C to +105°C) | SO(SOT-23) |
| MH493ISO-D-T | I (-40°C to +105°C) | SO(SOT-23) |

## *Functional Diagram*




## *Absolute Maximum Ratings* *At (Ta=25℃)*

| Characteristics | | Values | Unit |
|---|---|---|---|
| Supply Voltage ($V_{DD}$) | | 8 | V |
| Reverse Voltage, ($V_{DDR}$) | | -0.5 | V |
| Output Voltage, ($V_{out}$) | | 8 | V |
| Output current, ($I_{OUT}$) | | 20 | mA |
| Operating Temperature Range, ($T_A$) | | -40 ~ +125 | ℃ |
| Storage temperature Range, ($T_S$) | | -65 ~ +150 | ℃ |
| Maximum Junction Temp, ($T_J$) | | 150 | ℃ |
| Thermal Resistance | UA/SO | 206/543 | ℃/W |
| | UA/SO | 148/410 | ℃/W |
| Package Power Dissipation, ($P_D$) | UA/SO | 606/230 | mW |

***Note**: Do not apply reverse voltage to* $V_{DD}$ *and* $V_{OUT}$ *Pin, It may be caused for Miss function or damaged device.*

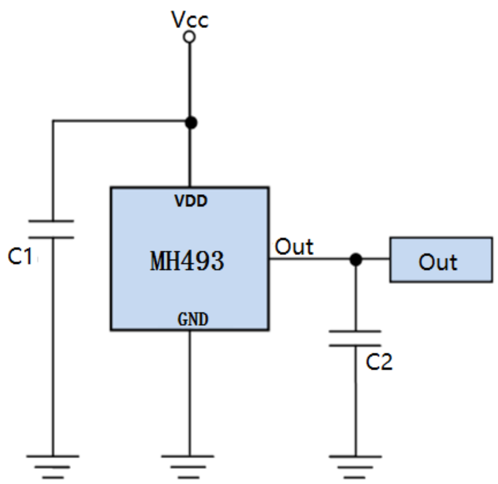
## *Electrical Specifications*

*DC Operating Parameters ： $T_A$=+25℃, $V_{CC}$=5.0V*

| Parameters | Test Conditions | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Supply Voltage, ($V_{DD}$) | Operating | | 2.8 | | 6.0 | V |
| Supply Current, ($I_{DD}$) | B= 0 Gauss | | | 3.3 | 5.0 | mA |
| Output Current, ($I_O$) | $V_{DD}$ > 3V | | 1.0 | 1.5 | | mA |
| Null Output Voltage, ($V_{NULL}$) | A | B= 0 Gauss, (T Type) | 2.375 (2.475) | 2.5 | 2.625 (2.525) | V |
| | B | B= 0 Gauss, (T Type) | 2.35 (2.45) | 2.5 | 2.65 (2.55) | V |
| | C | B= 0 Gauss, (T Type) | 2.325 (2.400) | 2.5 | 2.675 (2.600) | V |
| | D | B= 0 Gauss, (T Type) | 2.275 (2.375) | 2.5 | 2.725 (2.625) | V |
| High Output Voltage, ($V_{OH}$) | B> Max Magnetic Gauss | | | 4.9 | 4.99 | V |
| Low Output Voltage, ($V_{OL}$) | B> Min Magnetic Gauss | | 0.01 | 0.1 | | V |
| Output Voltage Span, ($V_{OS}$) | | | | 4.8 | | V |

| | | | | | | |
|---|---|---|---|---|---|---|
| Output Referred Noise, ($V_{ON}$) | Ta=25°C, C2=10nF | A | | | 80 | mV |
| | | B | | | 120 | mV |
| | | C | | | 130 | mV |
| | | D | | | 140 | mV |
| Power-On Time, ($T_P$) | | | | | 150 | uS |
| Output Switch Time, ($T_{SW}$) | | | | | 150 | uS |
| Output Switch Frequency, ($F_{SW}$) | | | 3 | | | kHz |
| Magnetic Range Gauss | A | | | ±600 | | Gauss |
| | B | | | ±343 | | Gauss |
| | C | | | ±240 | | Gauss |
| | D | | | ±185 | | Gauss |
| Ratiometry Null output error, ($R_{VON}$) | Operating voltage range relative to 5V | | | ±1.5 | | % |
| Ratiometry Sensitivity error, ($R_{SEN}$) | Operating voltage range relative to 5V | | | ±1.5 | | % |
| Linearity, ($LIN$) | % of Span | | | ±1.5 | | % |
| Sensitivity | A | Standard, (T type) | 3.68 (3.80) | 4.0 | 4.32 (4.20) | mV/G |
| | B | Standard, (T type) | 6.44 (6.65) | 7.0 | 7.56 (7.35) | mV/G |
| | C | Standard, (T type) | 9.0 (9.5) | 10.0 | 10.8 (10.5) | mV/G |
| | D | Standard, (T type) | 11.7 (12.35) | 13.0 | 14.3 (13.65) | mV/G |
| Sensitivity Temperature Coefficient, ($TC_{Sens}$) | Ta=105°C, relative to Sens@25°C | | | ±0.1 | | %/°C |
| Delta null voltage, ($\Delta V_{ON}$) | Ta=105°C, relative to $V_{ON}$ @25°C | | | 20 | | mV |
| Electro-Static Discharge | HBM | | 4 | | | KV |

## *Typical application circuit*

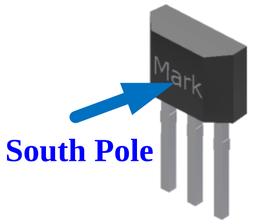



C1 ： 1nF/10V
C2 ： 10nF/10V

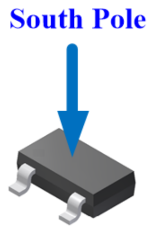
## *Output Behavior versus Magnetic Polar*

*DC Operating Parameters $T_A$ = -40 to 105℃, $V_{CC}$ =2.8V to 6.0 V*

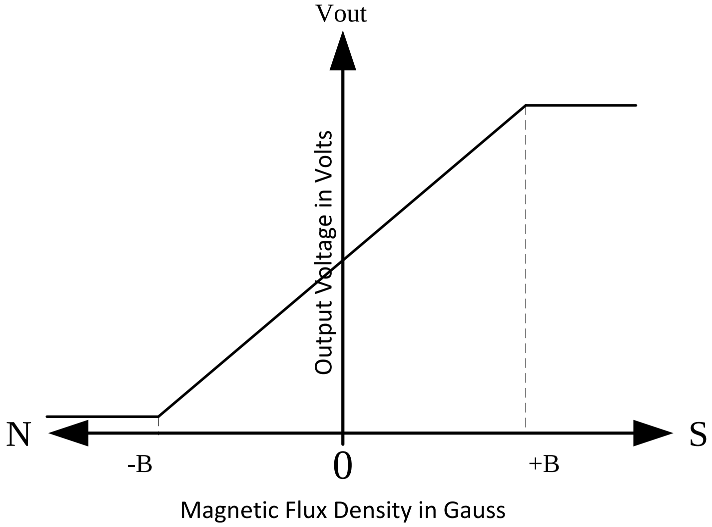
| *Parameter* | *Test condition* | *OUT(UA)* | *OUT(S0)* |
|---|---|---|---|
| **South pole** | B>0 Gauss | >$V_{NULL}$ | >$V_{NULL}$ |
| **North pole** | B<0 Gauss | <$V_{NULL}$ | <$V_{NULL}$ |




UA Package



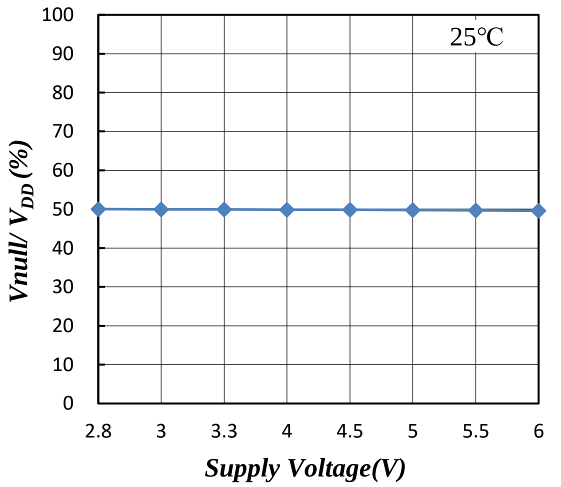

SO Package



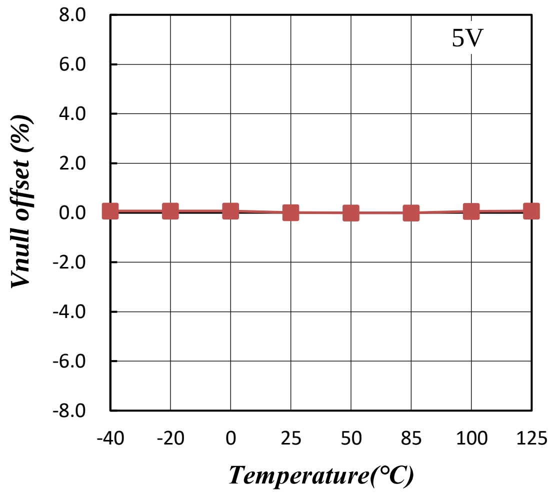

## *Performance Graph*

### *MH493-A/B/C/D*

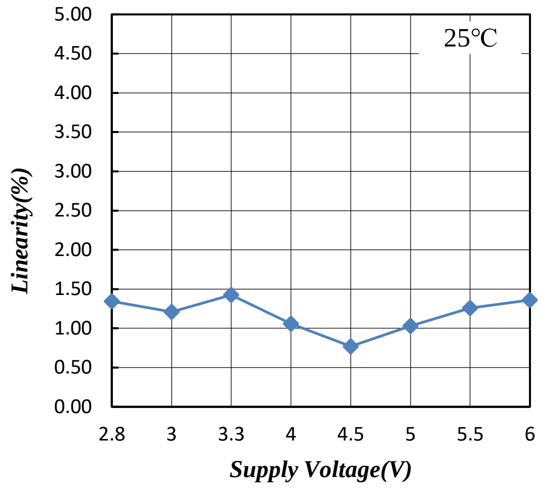
*Typical Supply Voltage ($V_{DD}$) Versus Ratio of $V_{NULL}$ to $V_{DD}$*



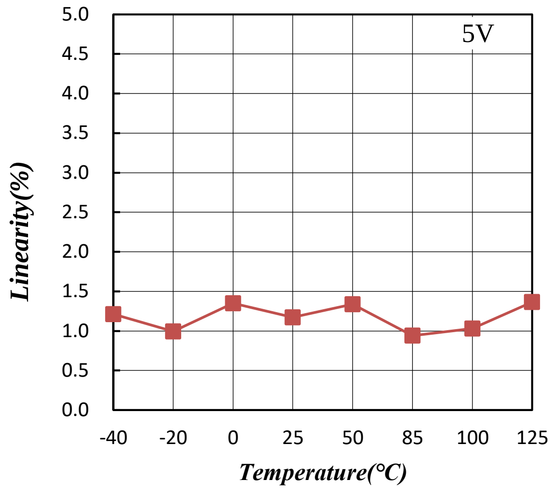

*Typical Temperature ($T_A$) Versus $V_{NULL}$ Offset*



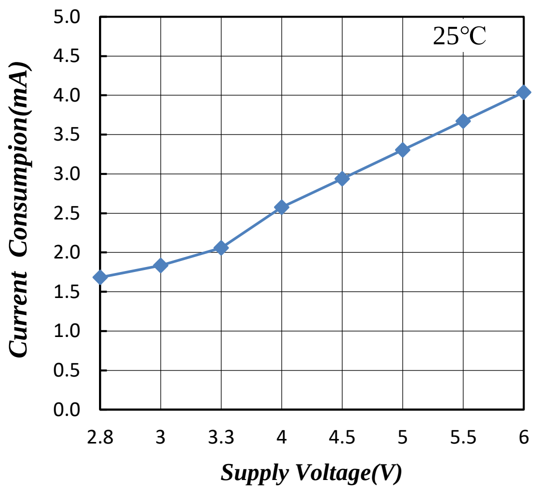
*Typical Supply Voltage ($V_{DD}$) Versus Linearity*



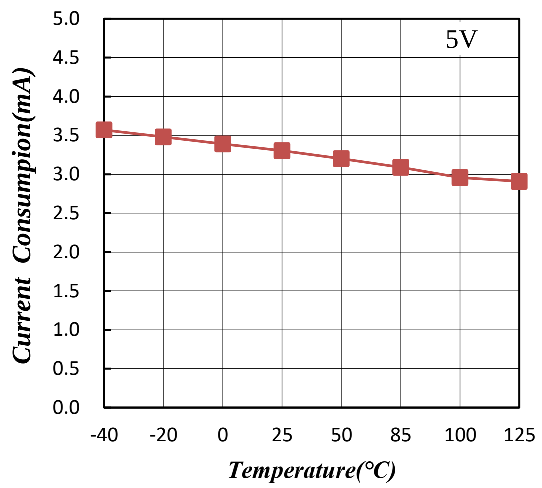

*Typical Temperature ($T_A$) Versus Linearity*



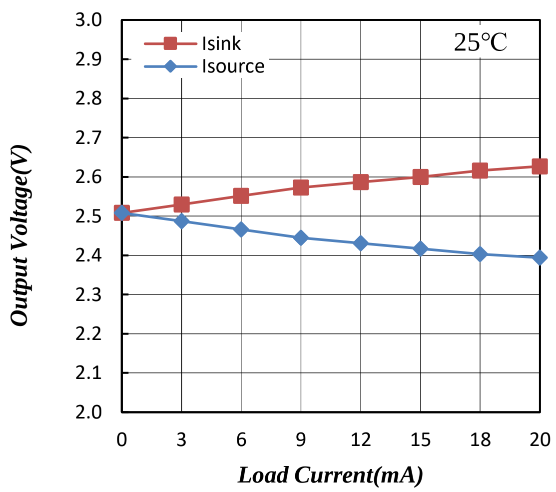

*Typical Supply Voltage ($V_{DD}$) Versus Supply Current ($I_{DD}$)*



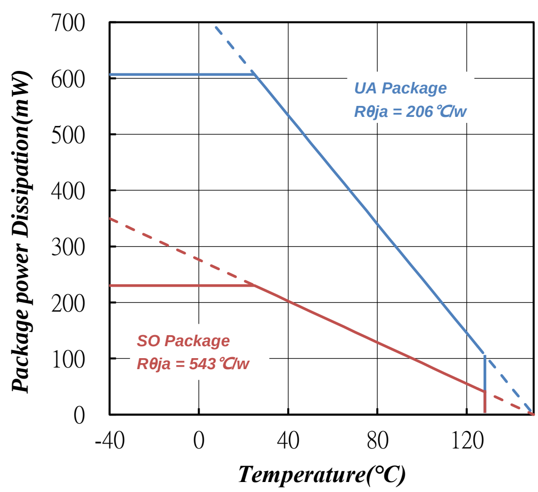

*Typical Temperature ($T_A$) Versus Supply Current ($I_{DD}$)*




*Load Current Versus Output Voltage*

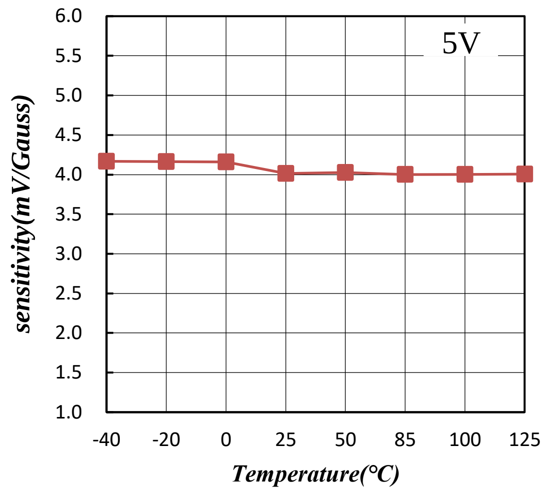



***Power Dissipation versus Temperature (TA)***

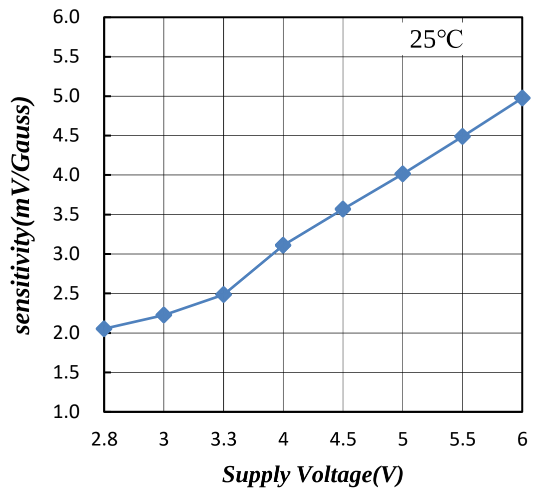


## MH493-A

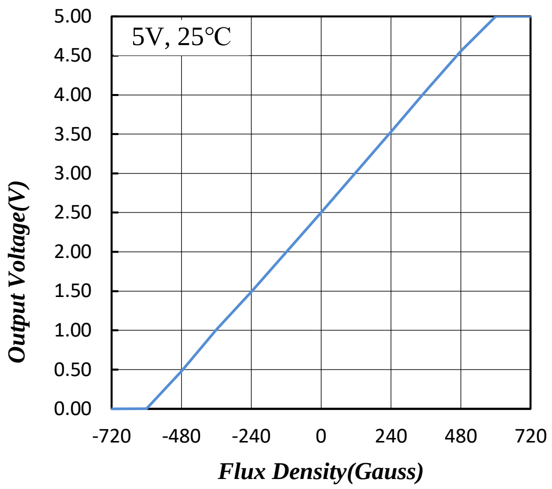
*Typical Temperature($T_A$) Versus Sensitivity*



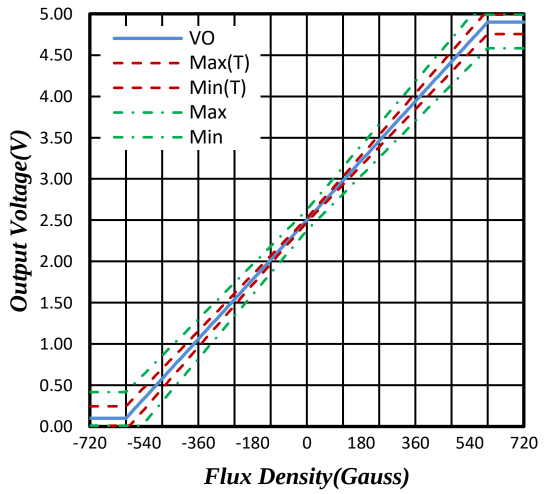

*Typical Supply Voltage($V_{CC}$) Versus Sensitivity*




*Practical Flux Density Versus Output Voltage*

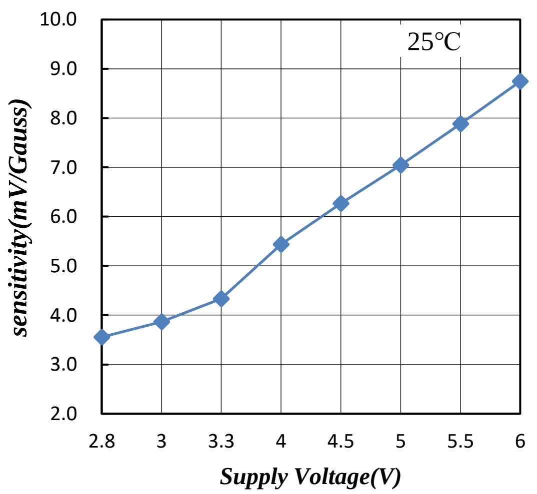



*Typical Supply Voltage($V_{CC}$) Versus Sensitivity*

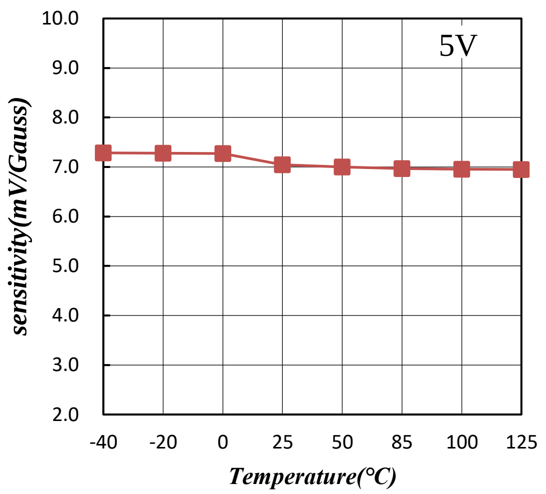



## MH493-B

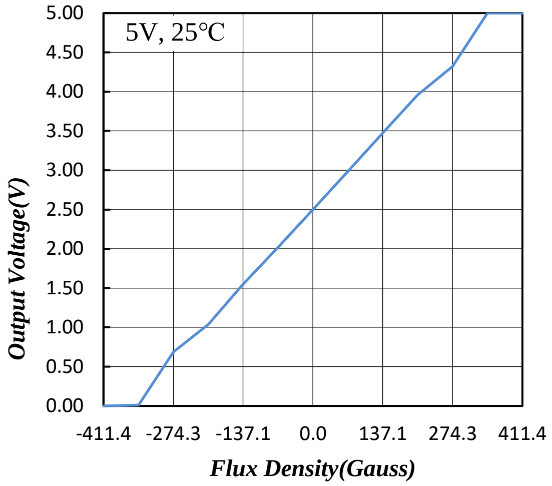
*Typical Supply Voltage ($V_{DD}$) Versus Sensitivity*



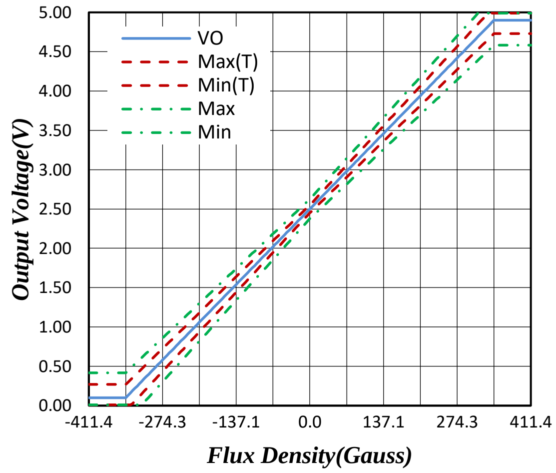

*Typical Temperature ($T_A$) Versus Sensitivity*



*Practical Flux Density Versus Output Voltage*

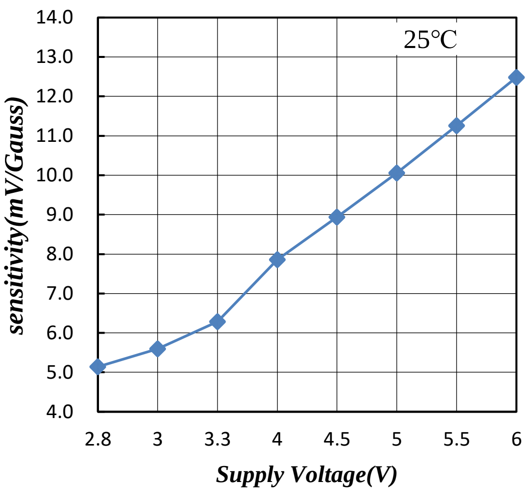



*Range of Flux Density Versus Output Voltage*

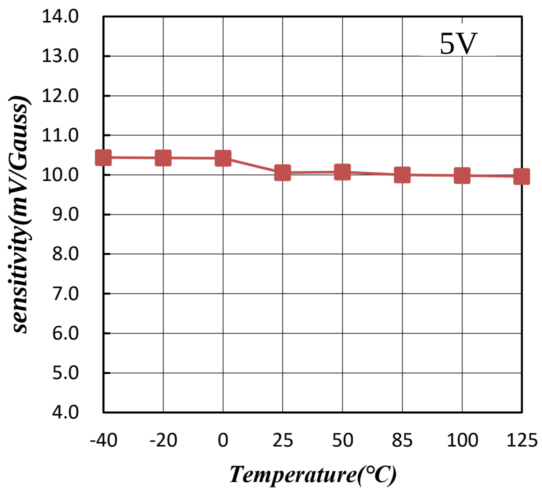



## *MH493-C*

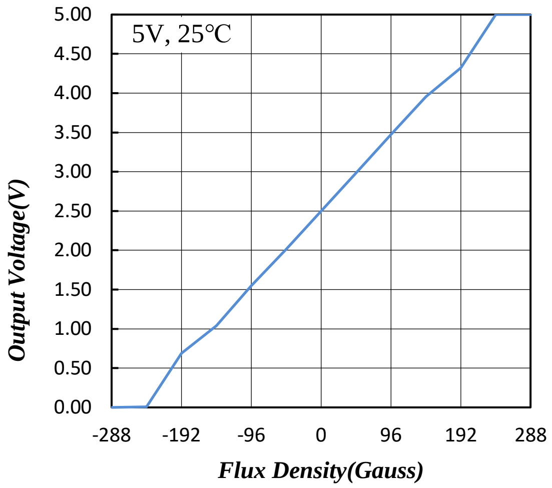
*Typical Supply Voltage ($V_{DD}$) Versus Sensitivity*



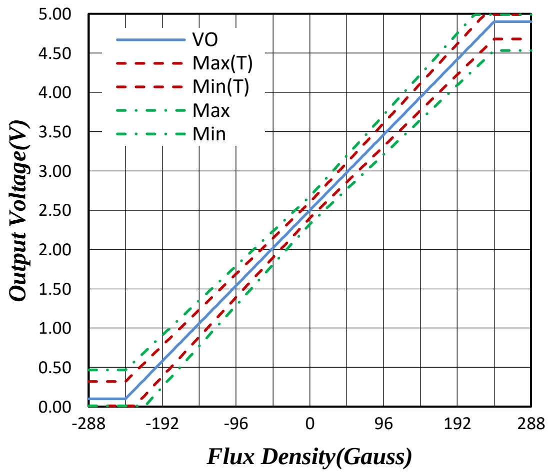

*Typical Temperature ($T_A$) Versus Sensitivity*




*Typical Flux Density Versus Output Voltage*

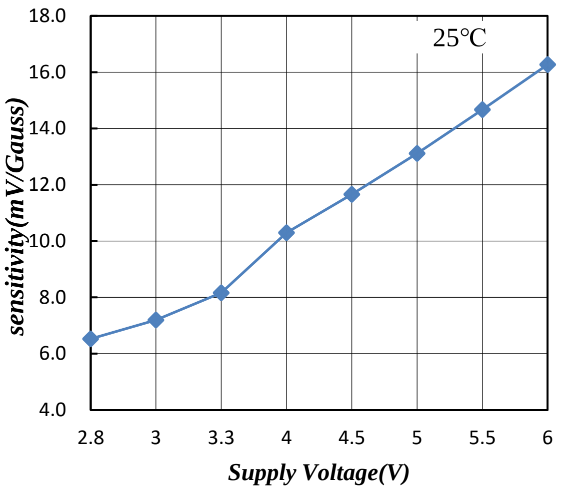



*Range of Flux Density Versus Output Voltage*

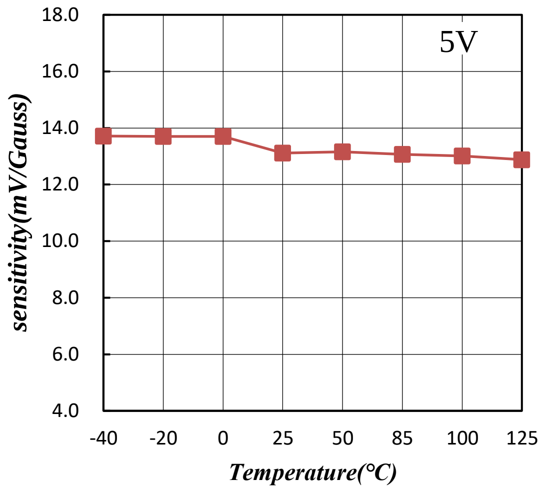


### *MH493-D*

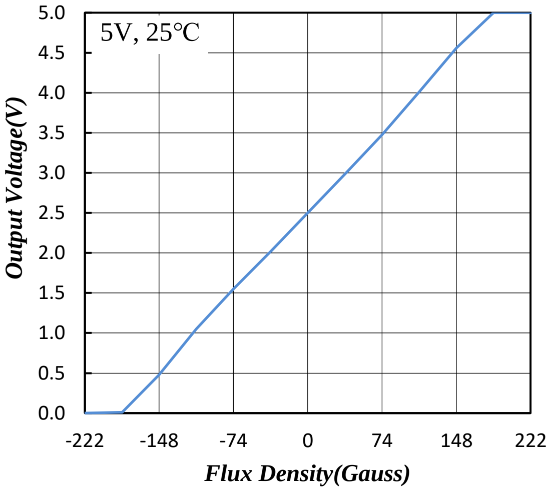
*Typical Supply Voltage ($V_{DD}$) Versus Sensitivity*



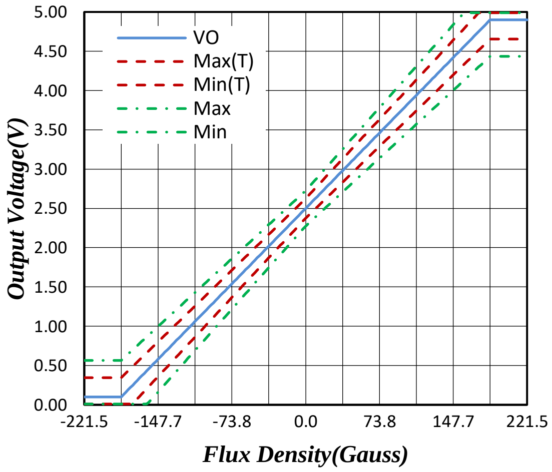

*Typical Temperature ($T_A$) Versus Sensitivity*




*Practical Flux Density Versus Output Voltage*




*Range of Flux Density Versus Output Voltage*




## ■ Function Description

### (1) $V_{DD}$ PIN

The pin is Supplied power to IC as circuit operation and output transition requirements, and the Supplied voltage must greater than the minimum operating voltage— 2.8V.

### (2) $V_{SS}$ PIN

The pin is connected to ground of the supplied power and must to be connected firmly.

### (3) Out PIN

The output pin is Totem-Pole type, don't place pull-high resistance. When there is no magnetic field, the output voltage is half of IC's $V_{DD}$. When the magnetic field is near the marking of IC, and magnetic force is South pole, this pin output state will larger than half of IC's $V_{DD}$. When the magnetic field is near the marking of IC, and magnetic force is north pole, this pin output state will less than half of IC's $V_{DD}$. Every time of the output transition must be after $T_{SW}$.

**(4) Power on Time**

When the applied voltage is into the device, the device output requires a response time to react to the ratiometry magnetic field.

**(5) Null Voltage output**

In the zero magnetic field state, the output voltage is half of the applied voltage $V_{DD}$.

**(6) Sensitivity**

The amount of the output voltage is proportional to the magnetic field's changes. This proportionality is specified as the below

$$\mathrm{Sens} = \frac{\mathrm{V_{OUT(B+)}} - \mathrm{V_{OUT(B-)}}}{(\mathrm{B}+) - (\mathrm{B}-)}$$

**(7) Linearity**

The device is designed to provide linear output in response to a ramping applied magnetic field. Consider two magnetic fields, B1 and B2. Ideally, the sensitivity of a device is the same for both fields, for a given applied voltage and temperature. The Linearity is calculated separately for positive and negative applied magnetic fields.

$$\mathrm{Lin_{B+}} = \left(1 - \frac{\mathrm{Sens_{(B2+)}}}{\mathrm{Sens_{(B1+)}}}\right) \times 100\ \ (\%)$$

$$\mathrm{Lin_{B-}} = \left(1 - \frac{\mathrm{Sens_{(B2-)}}}{\mathrm{Sens_{(B1-)}}}\right) \times 100\ \ (\%)$$

***(8) Ratiometry Error***

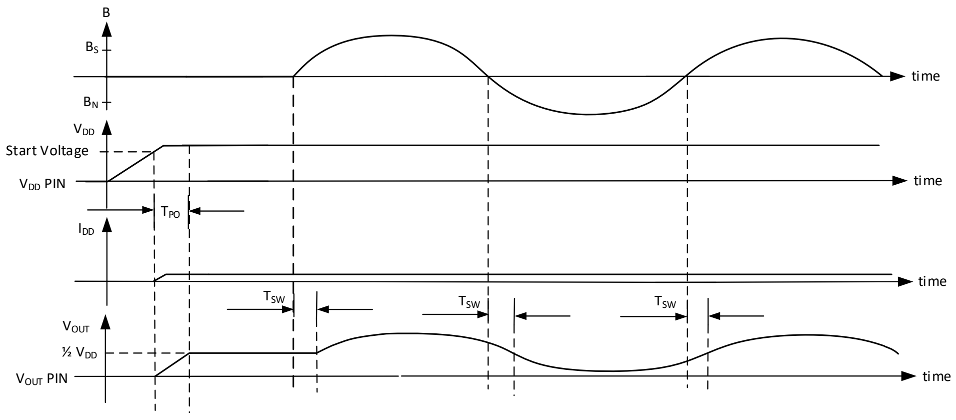
The device provides ratiometric output. The means that Null voltage output, $V_{NULL}$, and the magnetic sensitivity, Sens, are proportional to the applied voltage, $V_{DD}$. The ratiometric amount is relative to 5V, and defined as the below

$$R_{Von} = \left(1 - \frac{Vnull_{VDD}/Vnull_{5V}}{V_{DD}/5V}\right) \times 100\ \ (\%)$$

$$R_{sen} = \left(1 - \frac{Sens_{VDD}/Sens_{5V}}{V_{DD}/5V}\right) \times 100\ \ (\%)$$

# Timing waveform diagram

## Power on timing




- Power-On time ($T_{PO}$)：
  When input voltage to $V_{DD}$ of IC, IC can be normal working after Power-On Time ($T_{PO}$).
- Output switch time, ($T_{SW}$)：
  The time from magnetic field change to output signal begin to transit is called output switch time.

## *Package Power Dissipation*

The power dissipation of the Package is a function of the pad size. This can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R_{\theta JA}$, the thermal resistance from the device junction to ambient, and the operating temperature, Ta. Using the values provided on the data sheet for the package, PD can be calculated as follows:

$$P_D = \frac{T_{J(max)} - Ta}{R_{\theta ja}}$$

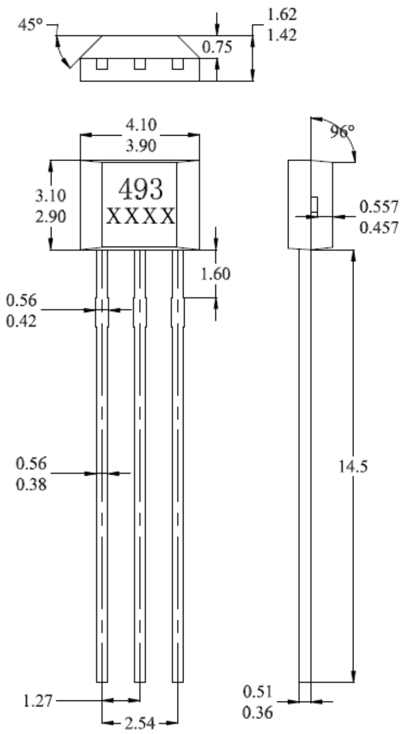
The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature Ta of 25°C, one can calculate the power dissipation of the device which in this case is 230 milliwatts.

$$P_D(SO) = \frac{150°C - 25°C}{543°C/W} = 230mW$$

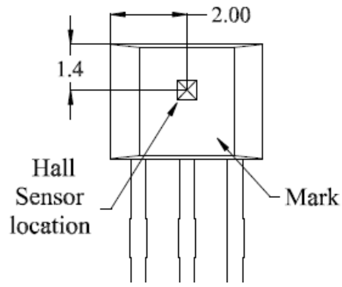
The 543°C/W for the SO package assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 230 milliwatts. There are other alternatives to achieving higher power dissipation from the Package. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad. Using a board material such as Thermal Clad, an aluminum core board, the power dissipation can be doubled using the same footprint.

## *Sensor Location, Package Dimension and Marking*

### UA package




### Hall Chip location




**NOTES:**

1. Controlling dimension: mm
2. Leads must be free of flash an plating voids
3. Do not bend leads within 1 mm of lead to package interface.
4. PINOUT:

   Pin 1 VCC

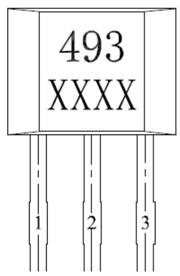
   Pin 2 GND

   Pin 3 Output
5. XXXX，$1^{st}$ X = A/B/C/D

   $2^{nd}$ -$4^{th}$ X=Date Code

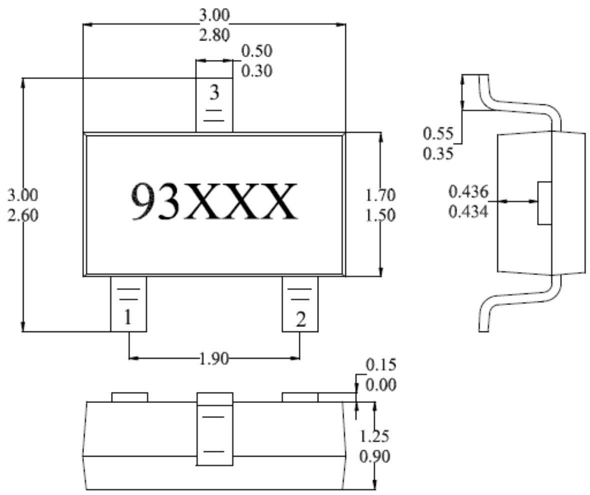
**Output Pin Assignment**

**(Top view)**



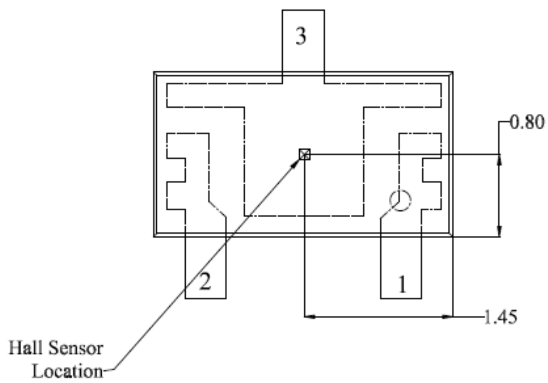

### SO Package

**(Top View)**

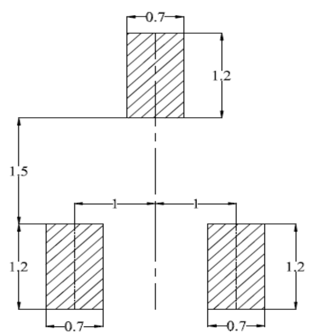



**Hall Plate Chip Location**

**(Bottom view)**




**(For reference only)Land Pattern**

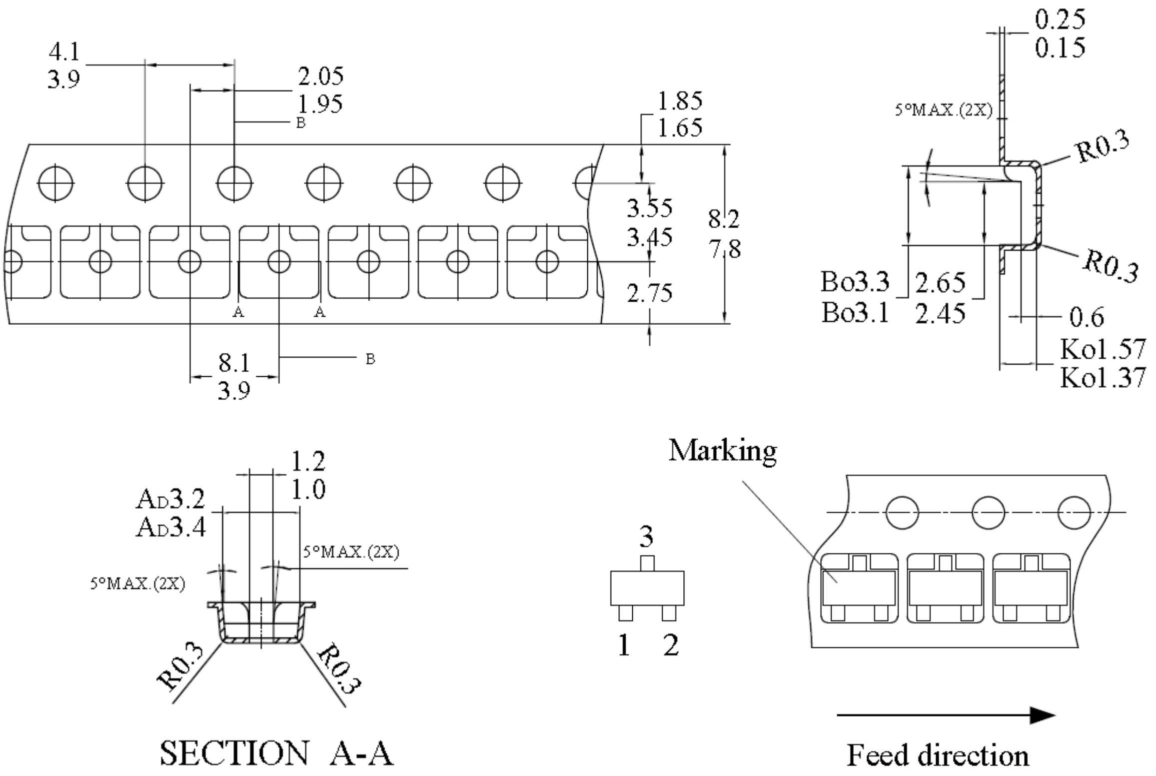


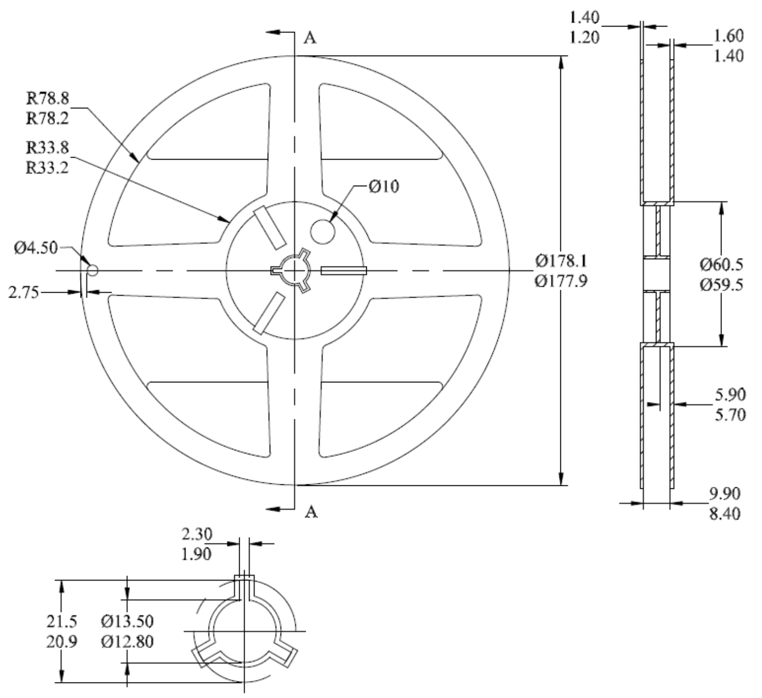

**NOTES:**

1. Controlling dimension: mm
2. Lead thickness after solder plating will be 0.254mm maximum
3. Chip must be in PKG. center.
4. PINOUT (See Top View at left :)

   Pin 1 $V_{DD}$; Pin 2 Output; Pin 3 GND
5. 93XXX，$1^{st}$ X = A/B/C/D $2^{nd}$~$3^{rd}$ =Date Code

## *Sot-23 package Tape On Reel Dimension*

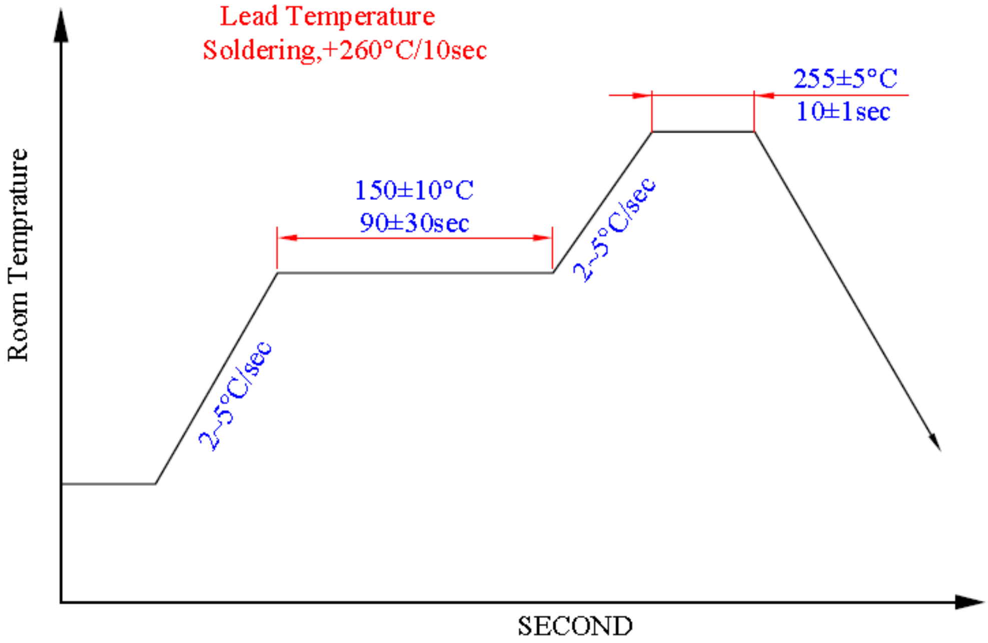


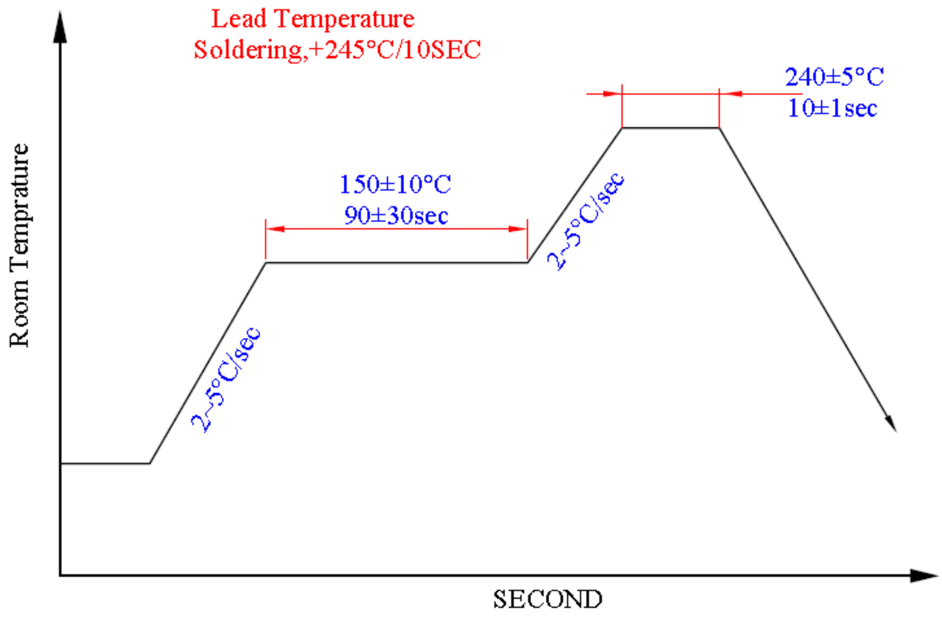

**NOTES:**

1. Material: Conductive polystyrene;
2. DIM in mm;
3. 10 sprocket hole pitch cumulative tolerance ±0.2;
4. Camber not to exceed 1mm in 100mm;
5. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole;
6. (S.R. OHM/SQ) Means surface electric resistivity of the carrier tape.

## *IR reflow curve*




**SO Soldering Condition**




**UA Soldering Condition**

## *Packing specification:*

| Package | Bag | Box | Carton | Carton | Carton |
|---|---|---|---|---|---|
| TO-92S-3L | 1,000pcs/bag | 10 bags/box | 10 boxes/carton | 5 boxes/carton | 4 boxes/carton |
| SOT-23-3L | 3,000pcs/reel | 5 reels/box | 6 boxes/carton | 6 boxes/carton | 6 boxes/carton |

| TO-92S-3L | Weight | SOT-23-3L | Weight |
|---|---|---|---|
| 1000pcs/bag | 0.11kg | 3000pcs/reel | 0.12kg |
| 10 bags/box | 1.26kg | 5 reels/box | 0.73kg |
| 10 boxes/carton | 13.38kg | 6boxes/carton | 4.84kg |
| 5 boxes/carton | 6.82kg | 6boxes/carton | 4.84kg |
| 4 boxes/carton | 5.54kg | 6boxes/carton | 4.84kg |

***SOT Package Inner box label*** ：Size: 5cm*8cm


***SOT Carton label*** ：Size: 6 cm * 9cm


***UA Package Inner box label*** ：Size: 5cm*8cm

***UA Carton label*：** Size: 6 cm * 9cm


## *Combine:*

When combine lot, one reel could have two D/C and no more than two DC. One carton could have two devices, no more than two;