KTH5641 Series

CMOS Ratio-Metric Linear Hall Effect IC

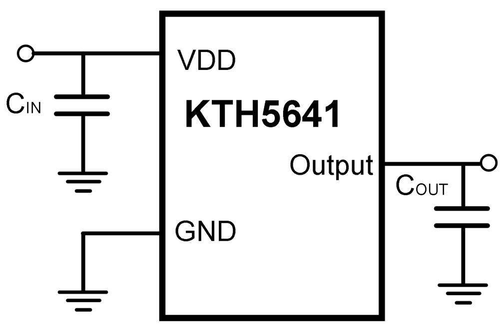
1 Features

- Ratio-Metric Linear Hall-effect Magnetic Sensor
- Wide Operating Voltage：2.8V~6.0V
- Low Power Consumption: 3.3mA@5.0V V_{DD}
- Low-Noise Output
- Responds to either Positive or Negative Gauss
- Sensitivity Adjustable:
  - A1：1.5mV/Gs，±1600Gs
  - A2：2.0mV/Gs，±1200Gs
  - A3：2.5mV/Gs，±960Gs
  - A4：3.0mV/Gs，±800Gs
- High Quality Package：SOT-23-3L　TO-92S
- Operating Temperature：-40℃~125℃
- Robust ESD Performance：HBM 4KV
- RoHS Compliant 2011/65/EU and Halogen Free

2 Applications

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

3 Typical Application Circuit



Note：C_{IN}：　1nF/10V

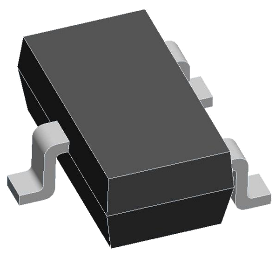
C_{Out}：10nF/10V

4 Descriptions

KTH5641 is a sensitivity adjustable of linear Hall-effect sensor, is composed of Hall sensor, linear amplifier and Totem-Pole output stage. It features low noise output, which use an external capacitance. It also can provide increased temperature stability and accuracy. The linear Hall sensor has a wide operating temperature range of -40℃ to +125℃, 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. That is proportional to the applied magnetics and features a null voltage output of half of the applied voltage.

KTH5641 family provides a variety of package to customers: SOT-23-3L, TO-92S. The two package styles available provide magnetically optimized solutions for most applications.

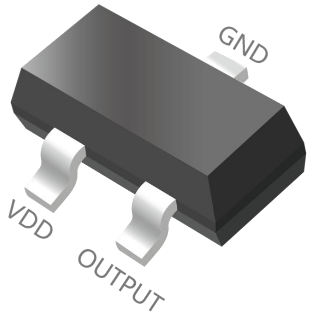


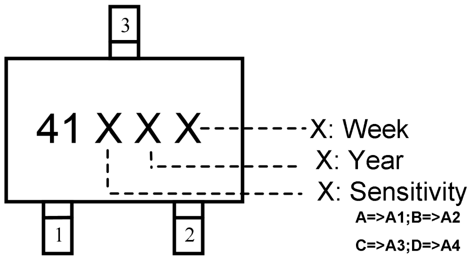
SOT-23-3L

TO-92S

5 Pin Description

SOT-23-3L

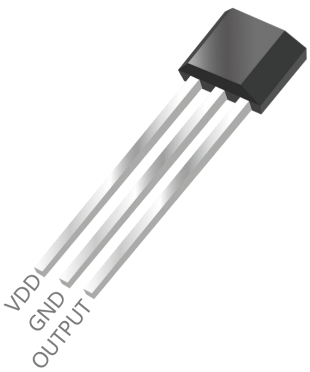


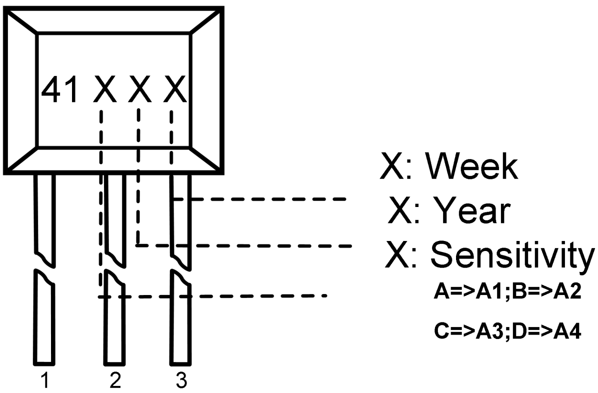


TOP VIEW

Pin Name	Pin No.	Function
VDD	1	Power Supply Input
OUTPUT	2	Output Pin
GND	3	Ground Pin

TO-92S

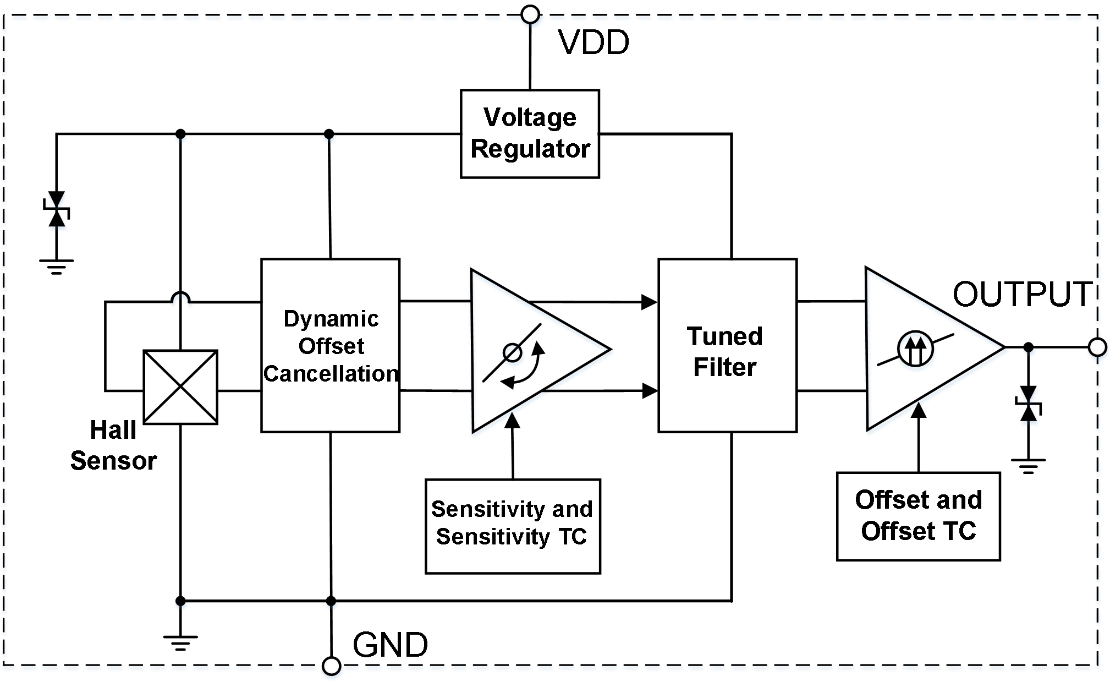




TOP VIEW

PIN Name	Pin No.	Function
VDD	1	Power Supply Input
GND	2	Ground Pin
OUTPUT	3	Output Pin

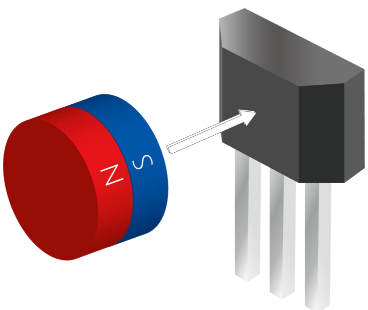
6 Block Diagram

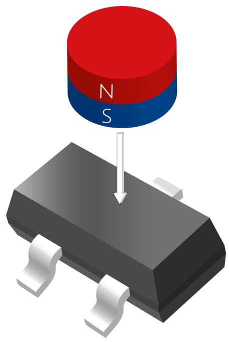


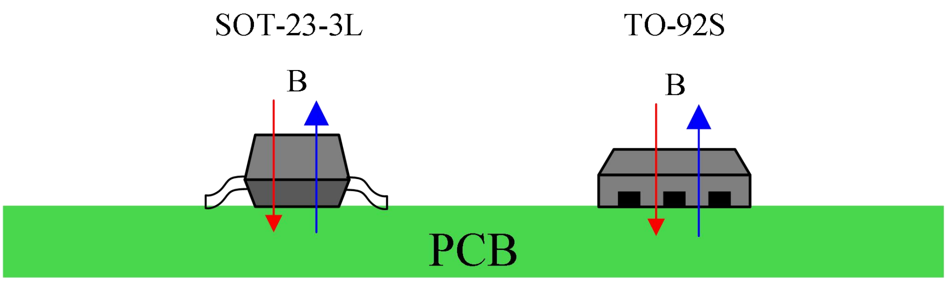
7 Output Characteristics (TA=-40℃~105℃， Vcc=2.8V~6.0V)

Symbol	Conditions	Output（TO-92S）	Output（SOT-23-3L）
South pole	B>0 Gauss	$>V_{NULL}$	$>V_{NULL}$
North pole	B<0 Gauss	$<V_{NULL}$	$<V_{NULL}$

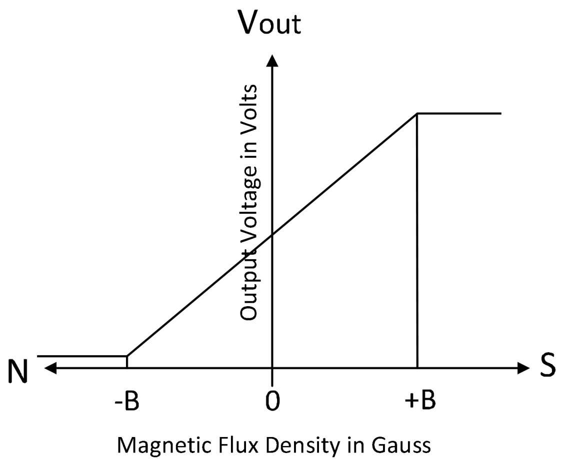
As shown in the figure below, the KTH5641 senses magnetic flux perpendicular to the top of the package. When the south pole of the magnet is close to the top of the chip, the magnetic induction line passes through from the bottom of the chip to the top, and the magnetic flux density B is considered positive at this time; When the north pole of the magnet is close to the top of the chip, the magnetic induction line passes from the top of the chip to the bottom, and the magnetic flux density B is considered negative at this time.







Output Switching Characteristics



8 Product Name Structure

KTH5641 XX-XXX

Package Abbreviation：ST3：SOT-23-3L
TO3：TO-92S

Sensitivity：A1:1.5mV/Gs A2: 2.0mV/Gs
A3: 2.5mV/Gs A4: 3.0mV/Gs

9 Absolute Maximum Ratings (@TA=+25℃,unless otherwise specified)

Symbol	Parameter		Value	Unit
V_{DD}	Supply Voltage		8	V
V_{DD_REV}	Reverse Voltage		-0.5	V
I_{OUTPUT}	Output current		20	mA
V_{OUTPUT}	Output Voltage		8	V
T_A	Operating Temperature Range		-40～+125	ºC
T_{STG}	Storage temperature Range		-65～+150	ºC
T_J	Maximum Junction Temp		+150	ºC
P_D	Package Power Dissipation	SOT-23-3L/TO-92S	230/606	mW
ESD HBM	Human Body Model ESD Capability		4000	V

Note: Exceeding the absolute maximum ratings may cause permanent damage. Exposure to absolute-maximum rated conditions for extended periods may affect device reliability.

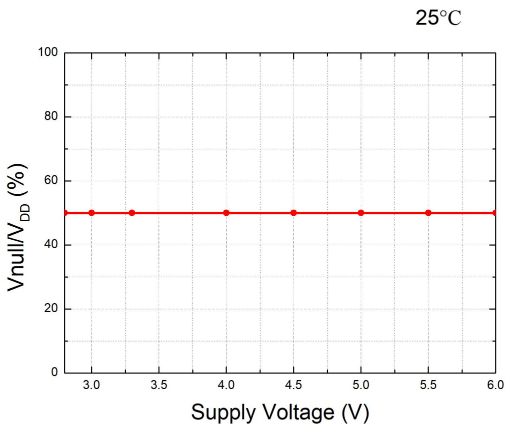
10 Electronics Characteristics (@TA=+25℃,V_{DD}=5.0V , unless otherwise specified)

KTH5641 Series						
Symbol	**Parameter**	**Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
V_{DD}	Supply Voltage	Operating	2.8	—	6.0	V
I_{DD}	Supply Current	Operating，B=0 Gs	—	3.3	5.0	mA
I_O	Output Current	A1, V_{DD}>4V	1.0	1.5	—	mA
I_O	Output Current	A2/A3/A4, V_{DD}>3V	1.0	1.5	—	mA
V_{NULL}	Null Output Voltage	B=0 Gs	2.375	2.5	2.625	V
V_{OH}	High Output Voltage	B> Max Magnetic Gauss	—	4.9	4.99	V
V_{OL}	Low Output Voltage	B> Min Magnetic Gauss	0.01	0.1	—	V
V_{OS}	Output Voltage Span	Operating	—	4.8	—	V
V_{ON}	Output Noise	Ta=25℃, C_{Out}=10nF, A1	—	—	30	mV
		Ta=25℃, C_{Out}=10nF, A2	—	—	40	mV
		Ta=25℃, C_{Out}=10nF, A3/A4	—	—	50	mV
T_P	Power-On Time	Operating	—	—	150	uS
T_{SW}	Output Switch Time	Operating	—	—	150	uS
F_{SW}	Output Switch Frequency	Operating	3	—		kHz
Magnetic Range		A1	-1600	—	1600	Gs
		A2	-1200	—	1200	Gs
		A3	-960	—	960	Gs
		A4	-800	—	800	Gs
Sensitivity		A1	1.38	1.5	1.62	mV/Gs
		A2	1.84	2.0	2.16	mV/Gs
		A3	2.3	2.5	2.7	mV/Gs
		A4	2.76	3.0	3.24	mV/Gs
R_{VON}	Ratiometry Null output error	Operating voltage range relative to 5V	—	±1.5	—	%
R_{SEN}	Ratiometry Sensitivity error	Operating voltage range relative to 5V	—	±1.5	—	%
LIN	Linearity	% of Span	—	±1.5	—	%

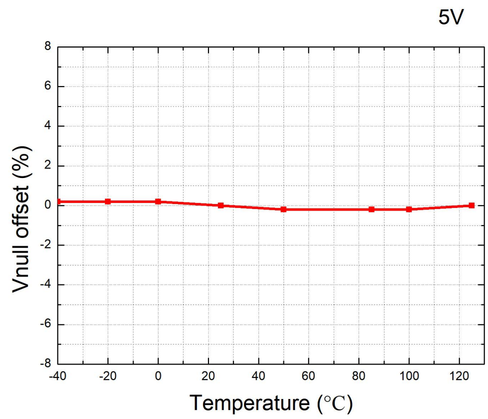
TC_{Sens}	Sensitivity Temperature Coefficient	Sens@125℃/Sens@25℃	—	±0.1	—	%/℃
δV_{ON}	Delta null voltage	$\lvert V_{ON}$@125℃-V_{ON}@25℃$\rvert$	—	20	—	mV

11 Characteristic Performance

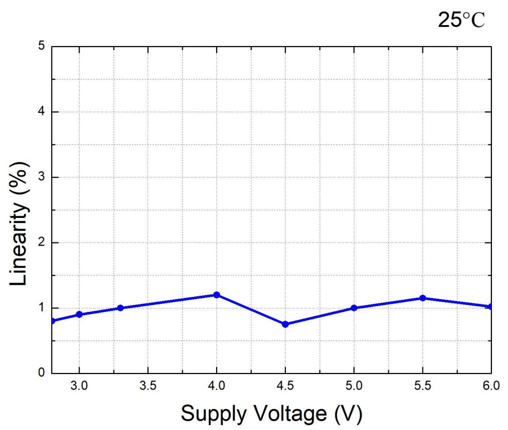
KTH5641A1/A2/A3/A4



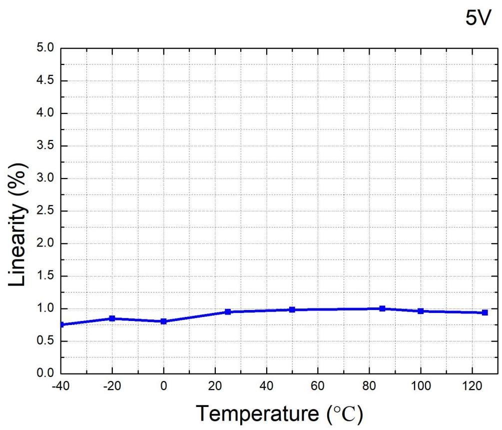
Typical Supply Voltage (V_{DD}) ***VS*** Ratio of V_{NULL} to V_{DD}



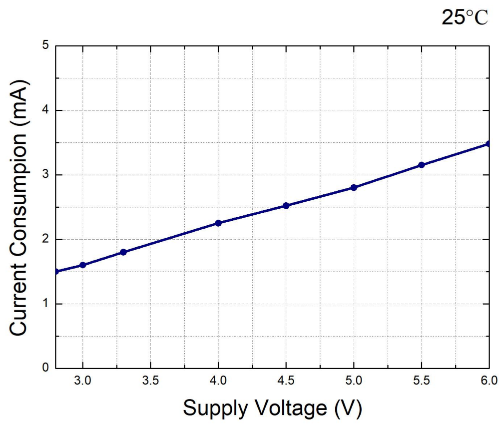
Typical Temperature (TA) ***VS*** V_{NULL} Offset



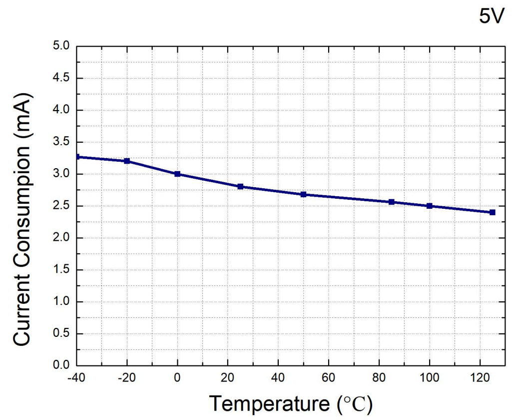
Typical Supply Voltage (V_{DD}) ***VS*** Linearity



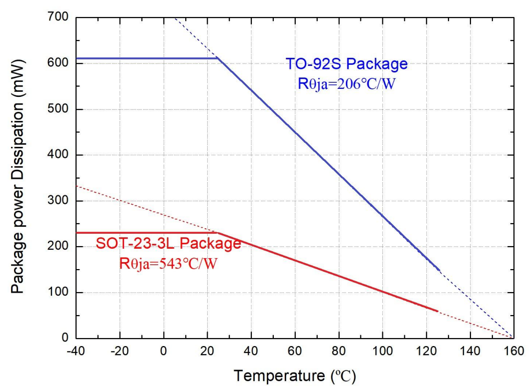
Typical Temperature (TA) ***VS*** Linearity



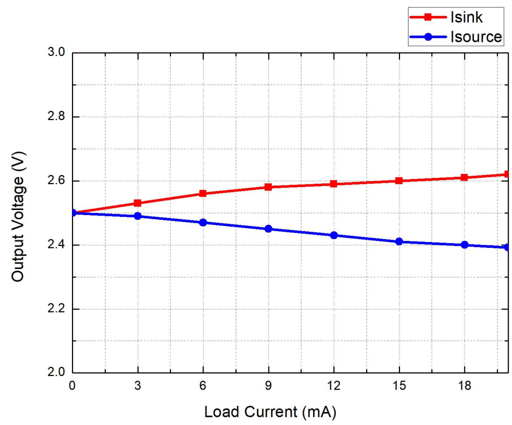
Typical Supply Voltage (V_{DD}) ***VS*** Supply Current (I_{DD})



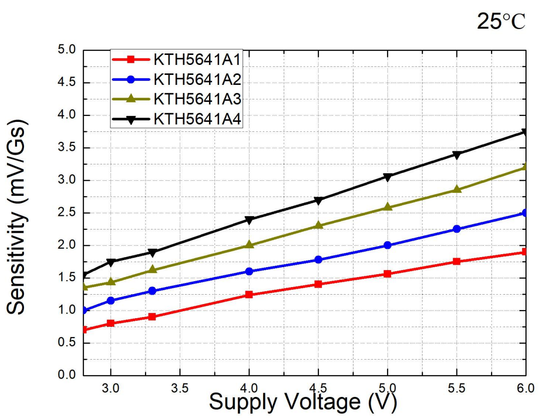
Typical Temperature (TA) ***VS*** Supply Current (I_{DD})



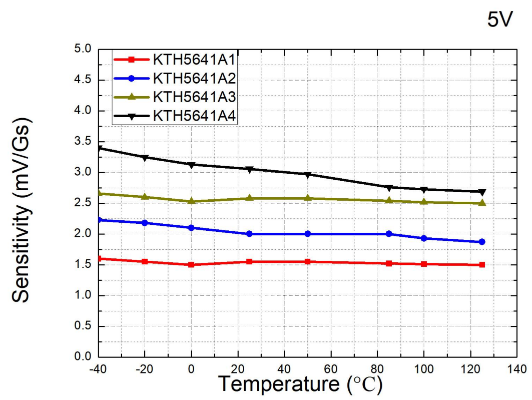
Power Dissipation ***VS*** Temperature(TA)



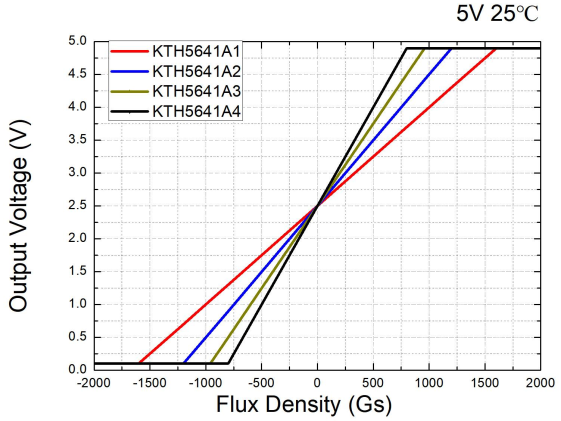
Load Current ***VS*** Output Voltage



Typical Supply Voltage(V_{DD}) ***VS*** Sensitivity



Typical Temperature (TA) ***VS*** Sensitivity



Typical Flux Density ***VS*** Output Voltage

12 Function Description

（1）V_{DD} Pin

This 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）GND Pin

This pin is the chip ground pin and needs to be strongly connected to the ground of the power supply.

（3）Output Pin

This 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:

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

（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.

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

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

（8）Ratiometry Error

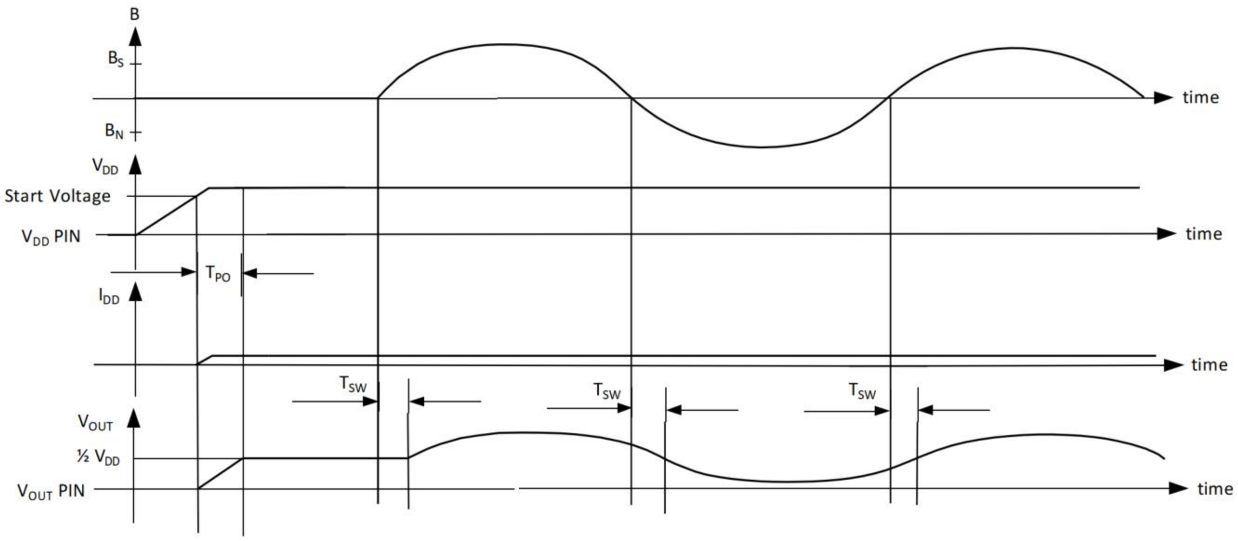
The device provides ratiometric output. It means that Null voltage output, V_{NULL}, and the magnetic sensitivity, Sens, are proportional to the applied voltage, V_{DD}. The ratiometric amount is relative to 5V, and defined as the below:

$$R_{Von} = (1 - \frac{\mathrm{Vnull}_{V_{DD}} / \mathrm{Vnull}_{5V}}{V_{DD}/5V}) \times 100\%$$

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

13 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}).

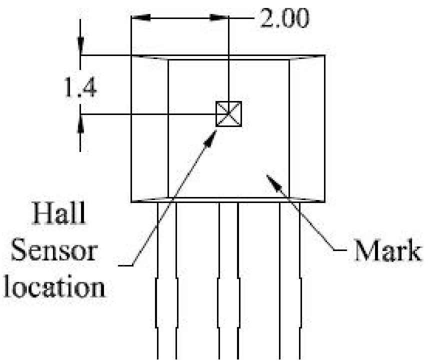
● Output switch time, (T_{SW})：

The time from magnetic field change to output signal begin to transit is called output switch time.

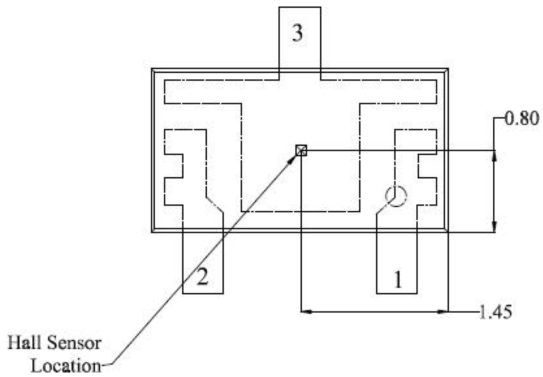
14 Order Information

Part No.	Package	Number of Pins	Sensitivity	Temperature
KTH5641A1-ST3	SOT-23-3L	3	1.5mV/Gs	-40℃~125℃
KTH5641A2-ST3	SOT-23-3L	3	2.0mV/Gs	-40℃~125℃
KTH5641A3-ST3	SOT-23-3L	3	2.5mV/Gs	-40℃~125℃
KTH5641A4-ST3	SOT-23-3L	3	3.0mV/Gs	-40℃~125℃
KTH5641A1-TO3	TO-92S	3	1.5mV/Gs	-40℃~125℃
KTH5641A2-TO3	TO-92S	3	2.0mV/Gs	-40℃~125℃
KTH5641A3-TO3	TO-92S	3	2.5mV/Gs	-40℃~125℃
KTH5641A4-TO3	TO-92S	3	3.0mV/Gs	-40℃~125℃

15 Hall Sensor Location



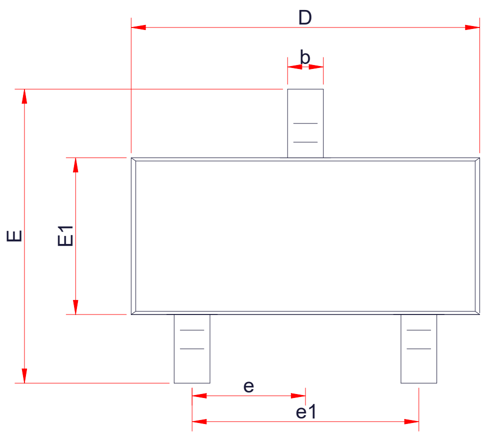
Top View



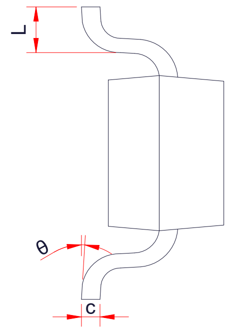
Bottom View

16 Package Outline Dimensions

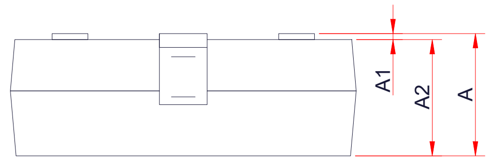
SOT-23-3L



TOP VIEW



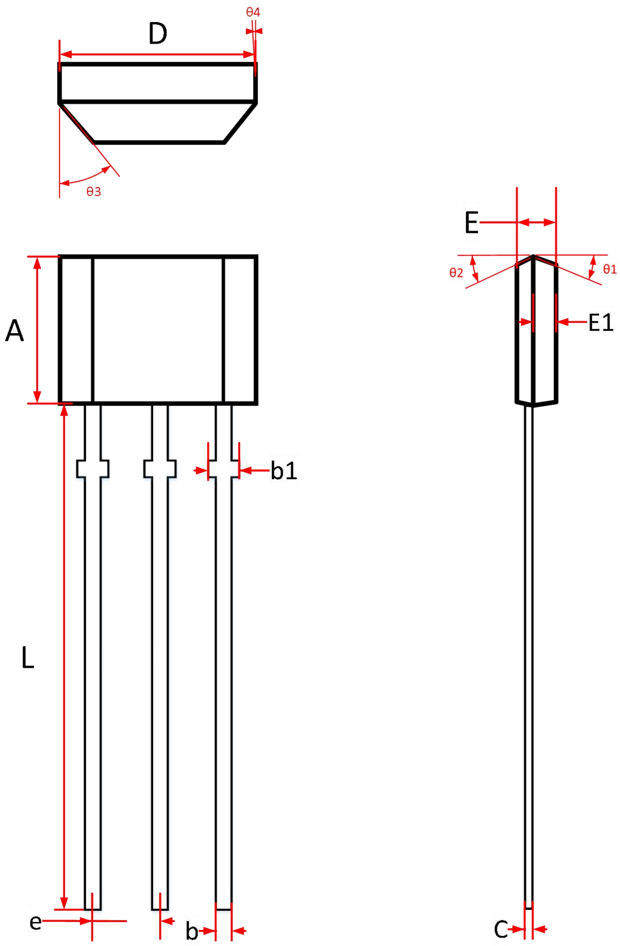
SIDE VIEW



SIDE VIEW

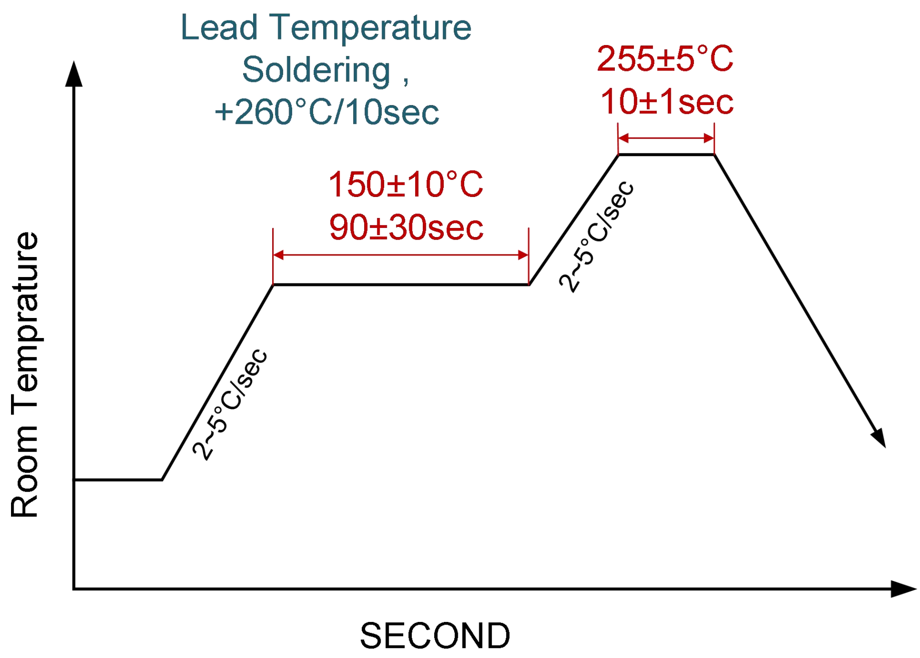
Symbol	Dimensions in Millimeters		
	Min.	**Typ.**	**Max.**
A	-	-	1.25
A1	0.00	-	0.1
A2	1.00	1.10	1.15
b	0.30	-	0.50
c	0.10	-	0.20
D	2.82	2.95	3.02
E	2.65	2.80	2.95
E1	1.50	1.65	1.70
e	0.85	0.95	1.05
e1	1.80	1.90	2.00
L	0.30	0.45	0.60
θ	0 °	-	8 °

TO-92S

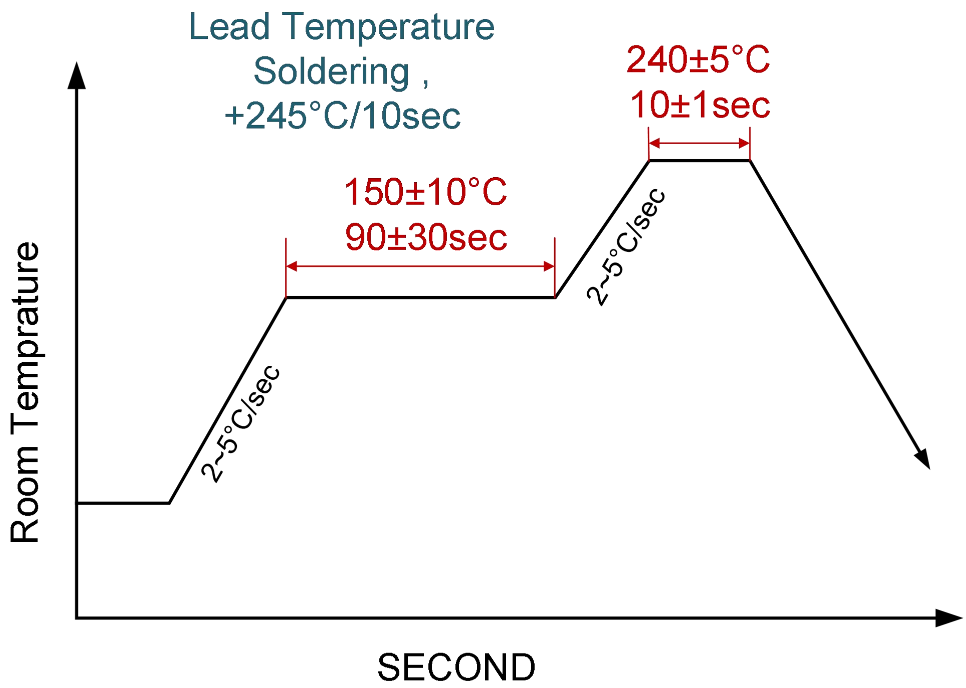


Symbol	Dimensions in Millimeters		
	Min.	Typ.	Max.
A	2.90	3.00	3.10
b	0.35	0.39	0.50
b1	0.40	0.44	0.55
C	0.36	0.38	0.45
D	3.90	4.00	4.10
E	1.42	1.52	1.62
E1		0.75	
e	1.27 TYP		
L	13.50	14.50	15.50
θ 1		6°	
θ 2		3°	
θ 3		45°	
θ 4		3°	

IR Reflow curve



SOT-23-3L Soldering Condition



TO-92S Soldering Condition