KTH2502 Series

**Automotive Digital-Latch
Hall Effect Sensor**

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Table of Contents

1 Product Features

The KTH2502 series is suitable for automotive applications:

- Device HBM ESD rating: 4000 V
- Device CDM ESD rating: 500 V
- Grade Q: $T_A = -40\,°C \sim 150\,°C$

Additional features include:

- Digital bipolar latching Hall sensor
- Excellent temperature stability: Full temperature range $B_{RP} \pm 10\%$
- Multiple sensitivity options (B_{OP} / B_{RP}):
  - A: $B_{OP} = \pm15\,G$, $B_{RP} = \pm15\,G$
  - B: $B_{OP} = \pm30\,G$, $B_{RP} = \pm30\,G$
  - C: $B_{OP} = \pm60\,G$, $B_{RP} = \pm60\,G$
- Wide operating voltage range: 2.7 V to 32 V, no external regulator required
- Open-drain output (30-mA sink current)
- Fast power-on time: 35 µs
- Small package sizes:
  - Surface mount: 3-Pin SOT23 and SOT-23-3L
  - Through-hole: 3-Pin TO-92S
- AEC-Q100 automotive standard compliant
- Protection features:
  - Reverse power protection (up to $-22\,V$)
  - Load dump protection up to 36 V
  - Output short-circuit protection
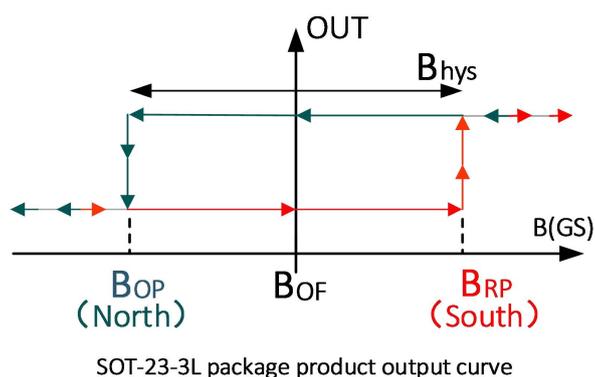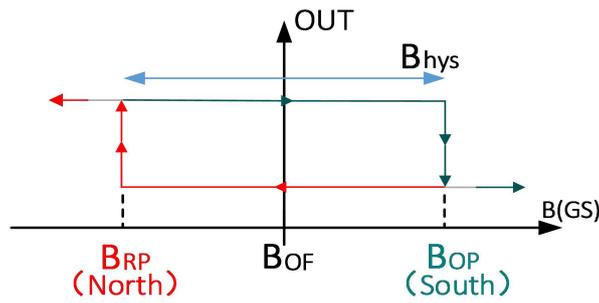 - Output current limit

SOT-23-3L package product output curve

Figure 1: Output curve of the SOT-23-3L package

2 Applications

The KTH2502 series is ideal for:

SOT23, TO-92S package product output curve

Figure 2: Output curve of the SOT23 and TO-92S package

- Power tools
- Flow meters
- Valve and solenoid status
- Brushless DC motors
- Proximity sensing
- Tachometers
- Sunroof controllers
- Tailgate controllers
- Folding blind controllers
- Seat adjustment controllers

3 Typical Application Circuits

4 Ordering Information

Model	Number of pins	Package Type	Operating Temperature	MSL Level	SPQ
KTH2502QA-SS3	3	SOT23	$-40\,°C$ to $150\,°C$	1	3000
KTH2502QA-ST3	3	SOT-23-3L	$-40\,°C$ to $150\,°C$	1	3000
KTH2502QA-TO3	3	TO-92S	$-40\,°C$ to $150\,°C$	NA	1000
KTH2502QB-SS3	3	SOT23	$-40\,°C$ to $150\,°C$	1	3000
KTH2502QB-ST3	3	SOT-23-3L	$-40\,°C$ to $150\,°C$	1	3000
KTH2502QB-TO3	3	TO-92S	$-40\,°C$ to $150\,°C$	NA	1000
KTH2502QC-SS3	3	SOT23	$-40\,°C$ to $150\,°C$	1	3000
KTH2502QC-ST3	3	SOT-23-3L	$-40\,°C$ to $150\,°C$	1	3000
KTH2502QC-TO3	3	TO-92S	$-40\,°C$ to $150\,°C$	NA	1000

Table 1: Ordering Information for KTH2502 Series

5 Overview

The KTH2502 employs advanced chopping technology, integrating temperature compensation circuitry along with over-current and negative volt-
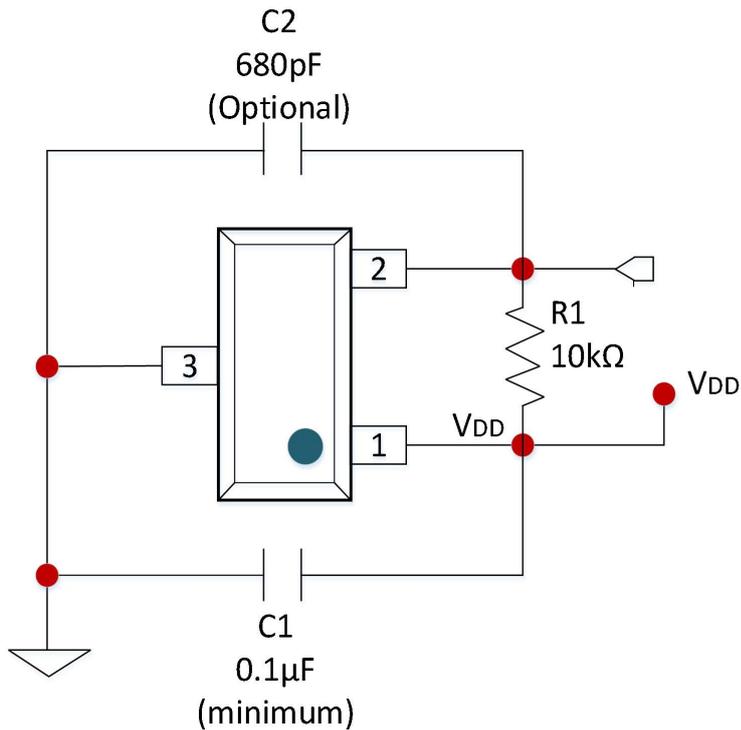
Figure 1. Typical Application Circuit

Figure 3: Typical application circuit for KTH2502

age protection circuits, providing excellent sensitivity and temperature stability. The magnetic field is indicated through a digital bipolar latch output. The chip features an open-drain output stage with a sink current capability of 30 mA. It operates over a wide voltage range from 2.7 V to 32 V, with reverse polarity protection up to −22 V, making it suitable for a wide range of automotive applications.

6 Pin Definitions

6.1 SOT23

Pin Name	Pin Number	Description
VCC	1	Power supply input
OUTPUT	2	Output
GND	3	Ground

Table 2: Pin Definitions for SOT23 Package
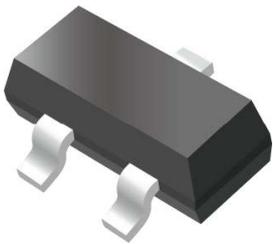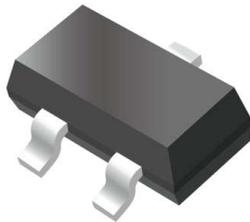
6.2 SOT-23-3L

6.3 TO-92S

Figure 4: SOT23 Package

Figure 5: SOT-23-3L Package

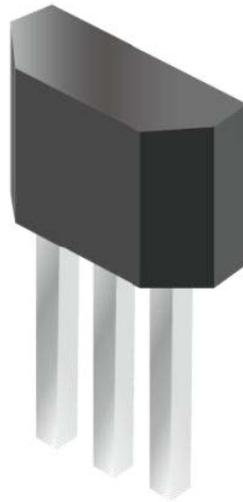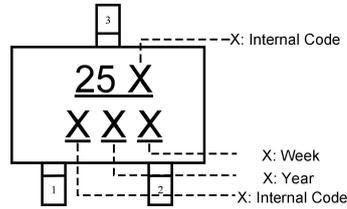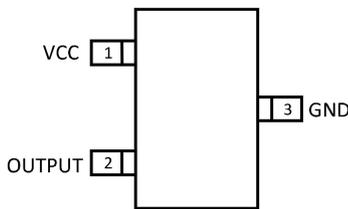Figure 6: TO-92S Package

Figure 7: SOT-23 Pinout Top View

7 Functional Block Diagram

8 Output Switching Characteristics

When the south pole of a magnet approaches the top of the chip, the magnetic flux lines pass from the bottom to the top of the chip, making the magnetic flux density B positive. When the north pole approaches the top of the chip, the flux lines pass from the top to the bottom, making B negative.

When the KTH2502 detects the presence of a magnetic field, it can accurately determine the magnetic poles and their strength.

9 Part Name Structure

The KTH2502 model construction is defined as follows:

10 Absolute Maximum Ratings

Exceeding the absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of

Figure 8: SOT-23-3L Pinout Top View

Pin Name	Pin Number	Description
VCC	1	Power supply input
OUTPUT	2	Output
GND	3	Ground

Table 3: Pin Definitions for SOT-23-3L Package

the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

(1) Design guaranteed.

11 ESD Ratings

The KTH2502 series has the following ESD ratings:

- Human Body Model (HBM): $\pm 4000\,\text{V}$
- Charged Device Model (CDM): $\pm 500\,\text{V}$

12 Recommended Operating Conditions

The following table lists the recommended operating conditions for the KTH2502 series:

(1) Power consumption and thermal limits must be observed.

13 Electrical Characteristics

The following table lists the electrical characteristics for the KTH2502 series over the recommended operating conditions, unless otherwise noted.
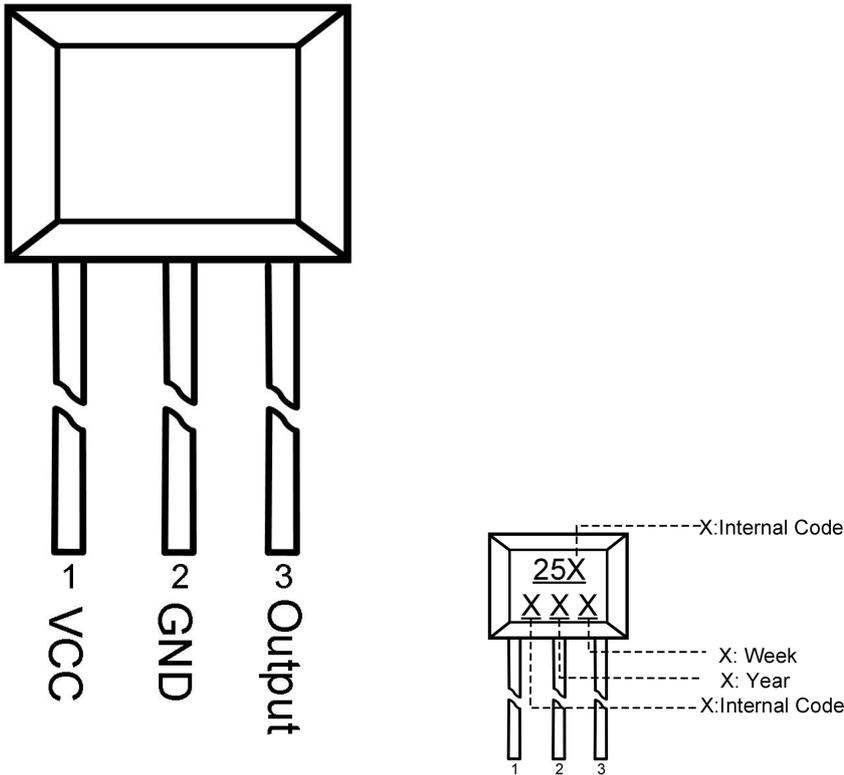
14 Magnetic Characteristics

The following table lists the electrical characteristics for the KTH2502 series over the recommended operating conditions, unless otherwise noted.

Figure 9: TO-92S Pinout Top View

Pin Name	Pin Number	Description
VCC	1	Power supply input
GND	2	Ground
OUTPUT	3	Output

Table 4: Pin Definitions for TO-92S Package

All parameters are measured over the test conditions of $T_A = -40°$C to $150°$C.

15 Performance Characteristics

The following figures illustrate various performance characteristics of the KTH2502 series.

16 Power-On Behavior

When the chip is powered on, it takes time t_{on} for the OUT pin to become active. During power-on, the output is Hi-Z. This pulse allows the host processor to determine whether the KTH2502 output is valid after startup. In Case 1 and Case 2, assuming a constant magnetic field $B > B_{OP}$ and $B < B_{RP}$, the output is defined.

If the magnetic field strength is $B_{RP} < B < B_{OP}$ when the chip is powered
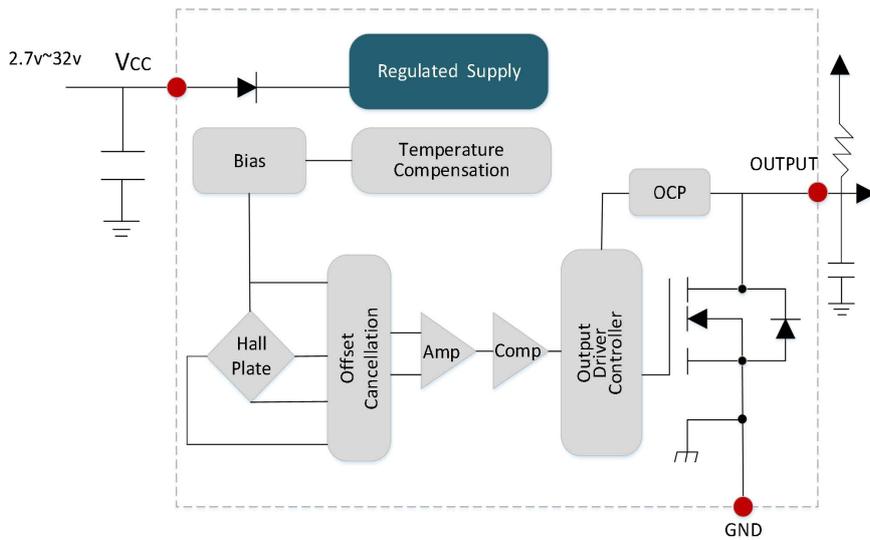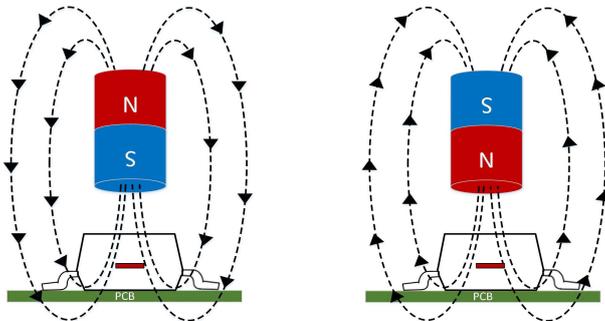
Figure 10: Functional Block Diagram of KTH2502

Figure 11: Magnetic Flux for SOT23

on, the output is pulled low. During power-on, the output remains Hi-Z until t_{on} has elapsed. At the end of t_{on}, a pulse is given on the OUT pin to indicate that t_{on} has passed. After t_{on}, if the magnetic field changes so that $B < B_{RP}$, the output is released. As shown in Case 3 and Case 4.

17 Output Stage

The KTH2502 uses an open-drain NMOS output stage rated for a sink current up to 30 mA. For proper operation, use the equation below to calculate the value of the pull-up resistor R1.

$$\frac{V_{ref\ max}}{30\ \text{mA}} \leq R1 \leq \frac{V_{ref\ min}}{100\ \mu\text{A}}$$

The value of R1 is a trade-off between the rise time on OUT and the current when OUT is pulled low. Lower current is generally better, but faster transitions and bandwidth require a smaller resistor to achieve faster switching. Additionally, ensure that $R1 > 500\ \Omega$ to allow the output driver to pull the OUT pin close to GND. Note: Vref is not limited to VCC. The allowed voltage range for this pin is specified in the absolute maximum ratings.
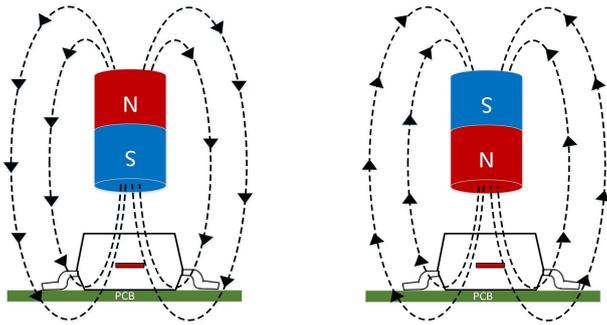
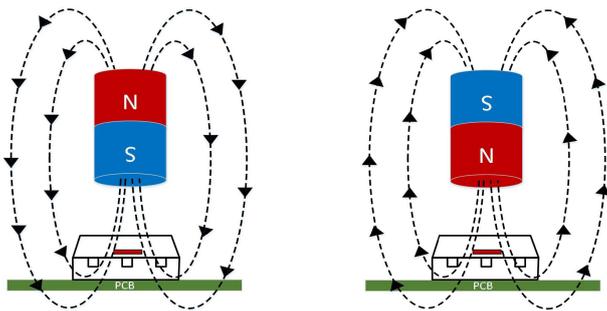Figure 12: Magnetic Flux for SOT23-3L

Figure 13: Magnetic Flux for TO-92S

Based on the system bandwidth specifications, select the value of C2 using the equation below.

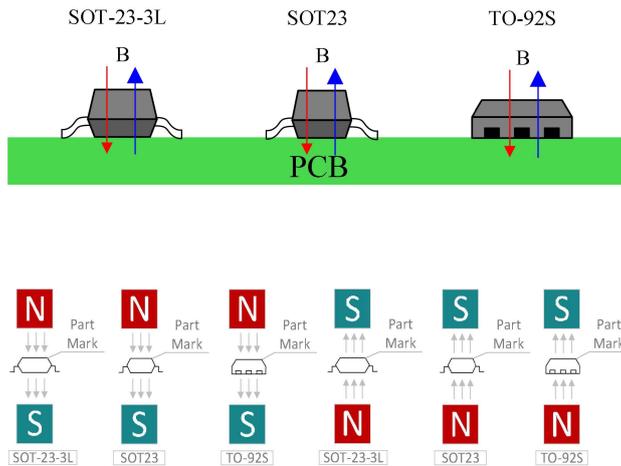$$2 \times f_{BW} \text{ (Hz)} < \frac{1}{2\pi \times R1 \times C2}$$

SOT-23-3L   SOT23   TO-92S

Figure 14: Magnetic Fields Detection in Different Packages

KTH2502 X X-XXX

Package abbreviation：ST3：SOT-23-3L ; SS3：SOT23
　　　　　　　　　　TO3：TO-92S
Magnetic sensitivity：A: B$_{OP}$=15GS; B: B$_{OP}$=30GS
　　　　　　　　　　C: B$_{OP}$=60GS
Grade：Q：150℃　Automotive grade
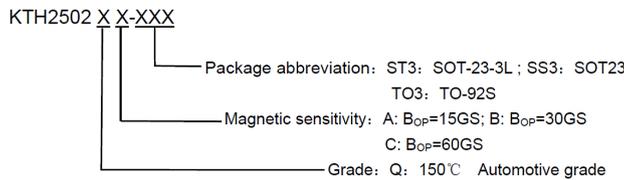
Figure 15: Chipset Name Structure

		Min	Max	Unit
Supply Voltage	VCC	-22[1]	36	V
	Voltage Ramp Rate (VCC), VCC < 5 V	Unlimited		V/μs
	Voltage Ramp Rate (VCC), VCC > 5 V	0	2	V/μs
Output Pin Voltage		-0.5	36	V
Reverse Output Pin Current		0	100	mA
Magnetic Flux Density, B_{MAX}		Unlimited		
Operating Junction Temperature T_J	Q	-40	150	°C
Storage Temperature, T_{stg}		-65	150	°C

Table 5: Absolute Maximum Ratings

Parameter	Min	Max	Unit
Supply Voltage, VCC	2.7	32	V
Output Pin Voltage, V_O	0	32	V
Output Pin Sink Current, I_{SINK} textsuperscript(1)	0	30	mA
Operating Temperature Range, T_A (Grade Q)	-40	150	°C

Table 6: Recommended Operating Conditions

Parameter	Test Conditions	Min	Typ	Max
Supply Voltage, V_{CC}		2.7		32
Operating Current, I_{CC}	V_{CC} = 2.7 to 32 V, T_A = 25°C		2.7	
Operating Current, I_{CC}	V_{CC} = 2.7 to 32 V, T_A = 150°C		2.7	4.5
Power-on Time, t_{ON}	Versions A, B, C		35	50
Open-Drain Output (OUT)				
FET On Resistance, $r_{DS(on)}$	V_{CC} = 3.3 V, I_O = 10 mA, T_A = 25°C		11	
FET On Resistance, $r_{DS(on)}$	V_{CC} = 3.3 V, I_O = 10 mA, T_A = 150°C		15	20
Off-state Leakage Current, $I_{lkg(off)}$	Output Hi-Z		500	
Output Delay Time, t_d	B = B_{RP} + 10 mT to B_{OP} - 10 mT in 1 µs (@SOT-23-3L)		10	25
Output Delay Time, t_d	B = B_{RP} - 10 mT to B_{OP} + 10 mT in 1 µs (@SOT23 & TO-92S)		10	25
Output Rise Time, t_r, (10% to 90%)	R_1 = 1 kΩ, C_O = 50 pF, V_{CC} = 3.3 V		160	
Output Fall Time, t_f (90% to 10%)	R_1 = 1 kΩ, C_O = 50 pF, V_{CC} = 3.3 V		80	
Protection Circuitry				
Reverse Supply Voltage, V_{CCR}		-22		
Over-current Protection Level, I_{OCP}	OUT shorted to V_{CC}	20	30	40

Table 7: Electrical Characteristics

| Parameter	Min	Typ	Max	Unit
Bandwidth, f_{BW}[1]	20	30		kHz
KTH2502QA: 15 / -15 GS				
Operating Point, B_{OP}	-25	-15	-5	GS
Release Point, B_{RP}	5	15	25	GS
Hysteresis, $B_{hys} = |B_{OP} - B_{RP}|$		30		GS
Magnetic Offset, $B_O = \frac{B_{OP}+B_{RP}}{2}$	-10	0	10	GS
KTH2502QB: 30 / -30 GS				
Operating Point, B_{OP}	-45	-30	-15	GS
Release Point, B_{RP}	15	30	45	GS
Hysteresis, $B_{hys} = |B_{OP} - B_{RP}|$		60		GS
Magnetic Offset, $B_O = \frac{B_{OP}+B_{RP}}{2}$	-15	0	15	GS
KTH2502QC: 60 / -60 GS				
Operating Point, B_{OP}	-90	-60	-30	GS
Release Point, B_{RP}	30	60	90	GS
Hysteresis, $B_{hys} = |B_{OP} - B_{RP}|$		120		GS
Magnetic Offset, $B_O = \frac{B_{OP}+B_{RP}}{2}$	-30	0	30	GS

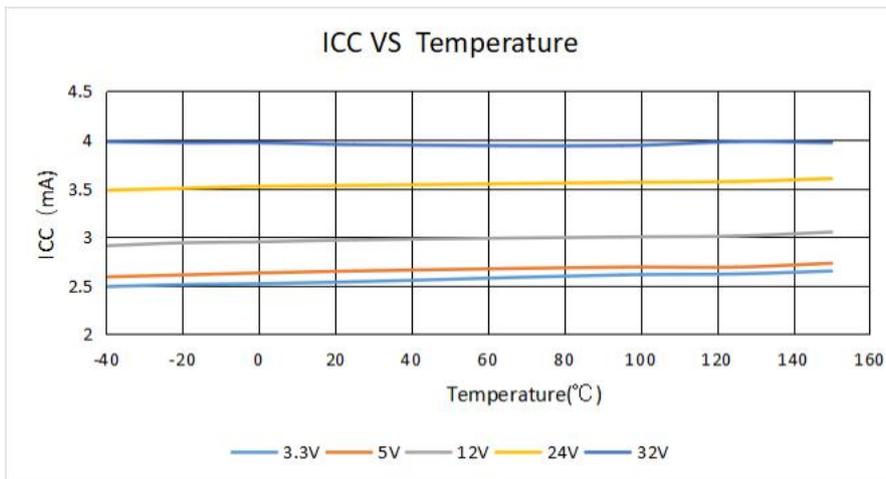Table 8: Magnetic Characteristics
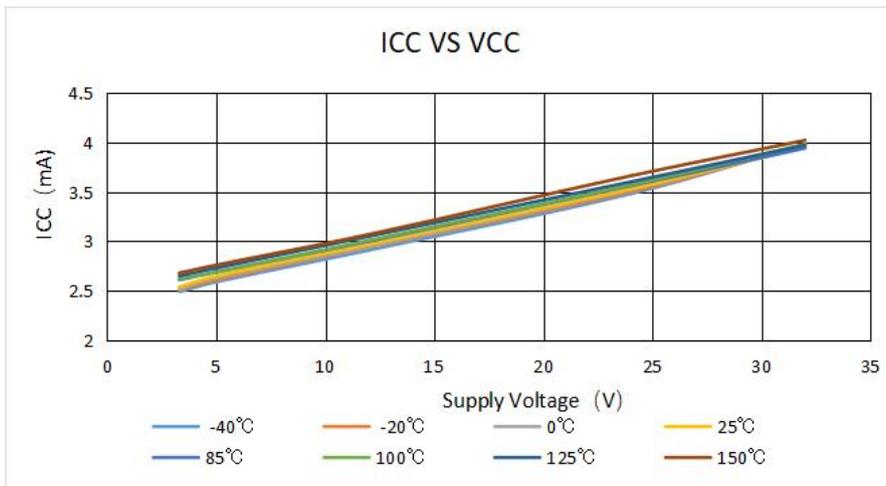
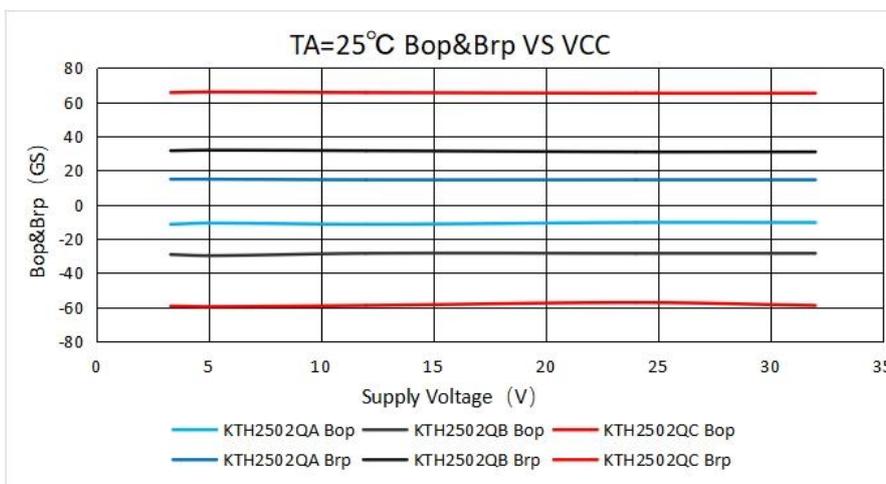Figure 16: Icc vs Vcc

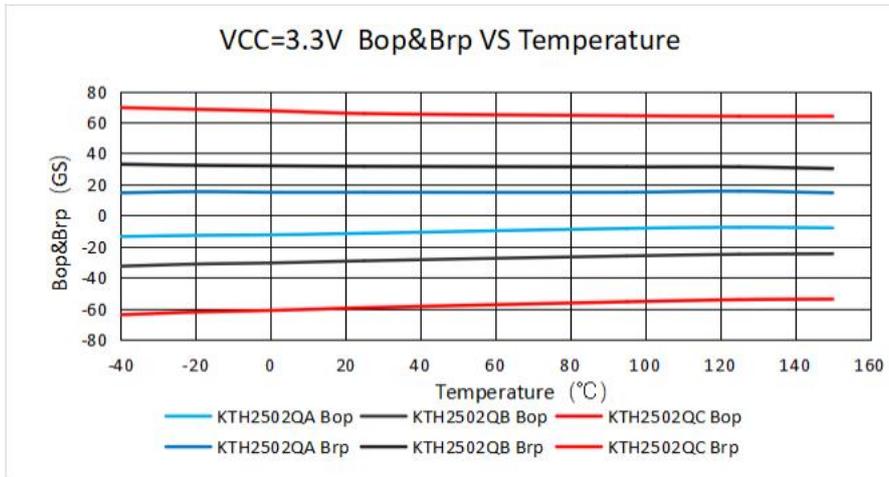Figure 17: Icc vs Temperature

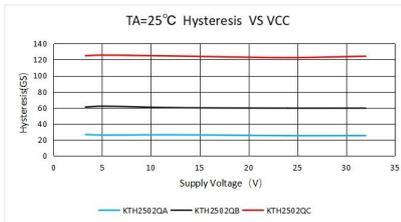Figure 18: Bop, Brp vs Vcc

Figure 19: Bop, Brp vs Temperature

Figure 20: Hysteresis vs Vcc

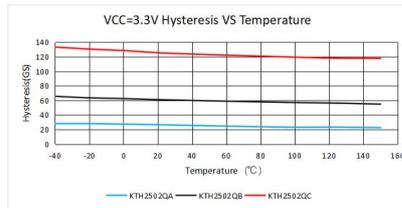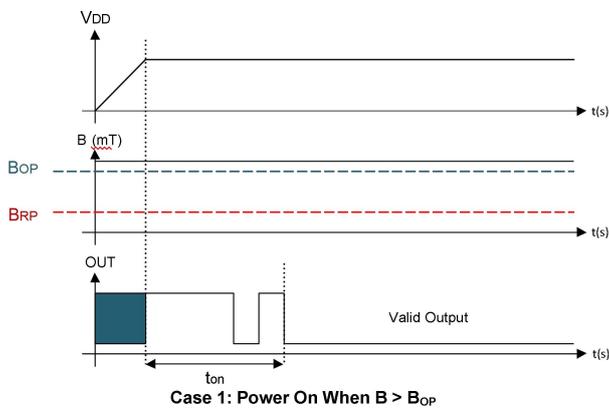
Figure 21: Hysteresis vs Temperature

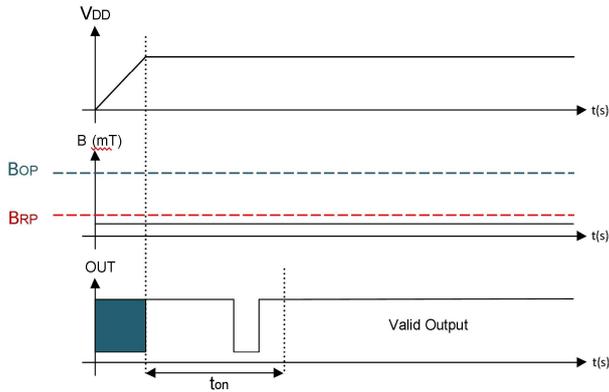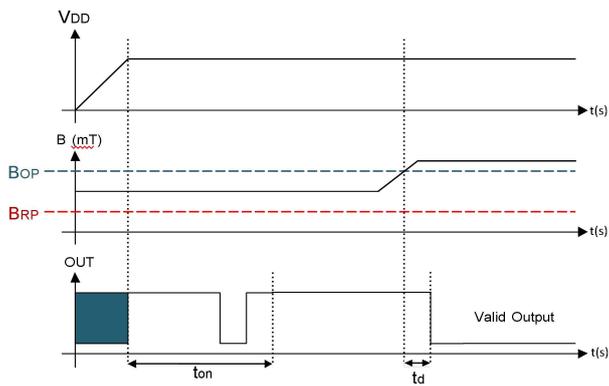Figure 22: Case 1: Power On, B > B_{OP}
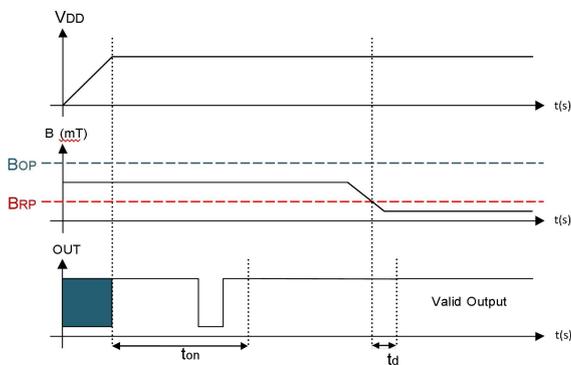
Case 2: Power On When B < B$_{RP}$

Figure 23: Case 2: Power On, B < B$_{RP}$

Case 3: Power On When B$_{RP}$ < B < B$_{OP}$, Followed by B > B$_{OP}$

Figure 24: Case 3: Power On, B$_{RP}$ < B < B$_{OP}$

Case 4: Power On When B$_{RP}$ < B < B$_{OP}$, Followed by B < B$_{RP}$
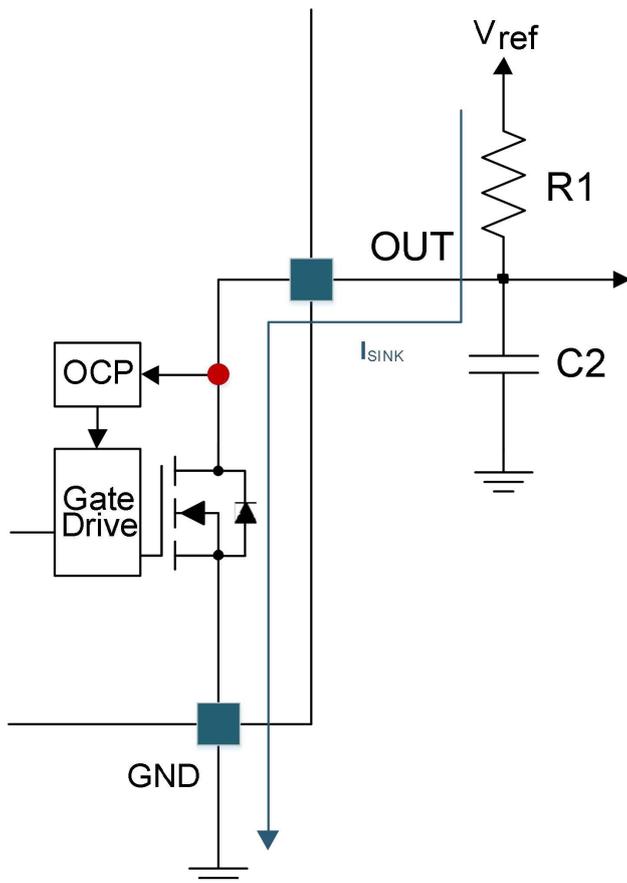
Figure 25: Case 4: Power On, B$_{RP}$ < B < B$_{OP}$

Figure 26: Output Stage