

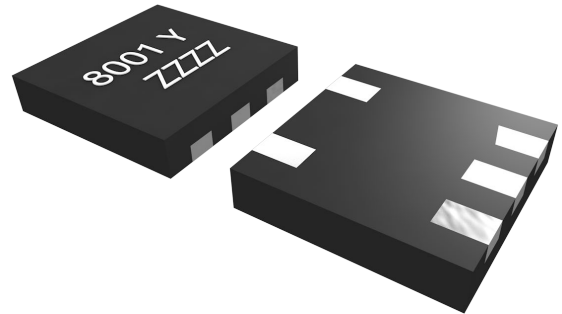
1 Product Description

MT8001 Hall effect sensor IC provides a 12-bit I2C digital code, which is proportional to the magnetic field strength present in the z-axis. MT8001 can be used in a wide range of accurate position sensing applications.

MT8001 can work in low power consumption auto sleep-turn on mode. The duty cycle of on-off phase can be programmed to appropriate value for applications.

MT8001 also integrated with a temperature sensor, and its compensation curve is pre-configured at the factory. In application, real time temperature calibration for on-chip hall sensor and magnetic field can be provided. Customer can calibrate sensitivity & offset through I2C interface after MT8001 is installed to system.

The MT8001 family provide DFN-1616 for surface mounting.



2 Features

- CMOS Technology
- 2.6~5V Operating Vcc Range
- Isleep < 5uA
- -20°C~85°C Operating Temperature
- I2C Interface
- Magnetic Field Calibration Function
- 12-bit Resolution Digital Output
- Package Option:
DFN1616
- Open Drain Output
- 8-bit Chip ID for Customer Use
- RoHS Compliant: (EU)2015/863

3 Product Overview of MT8001

Part No.	Description
MT8001DT-1616-XXXX	DFN1616, tape & reel (3000pcs/bag)

4 Applications

- Home Appliances
- Position Detection
- TWS
- AR/VR

5. Pin Configuration and Functions

DFN1616	Name	Description
1	Vcc	Power
2	GND	Ground
3	OUT	Open Drain Output
4	SCL/MFC_EN	Clock/MFC_NVM Control Pin
5	SDA	Data

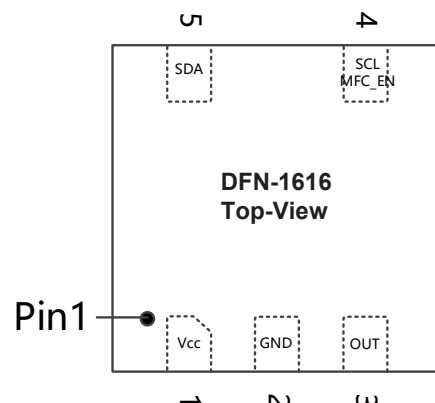


Figure.1 Pin Configuration & Functions

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Reversion History

1	1.0 Version	Original Version
2	1.1 Version	Update Register Map
3	1.2 Version	Update I ² C Timing Diagram
4	1.3 Version	Update the Electrical Specifications
5	1.4 Version	Update Register Map & Chip Marking

6 Functional Block Diagram

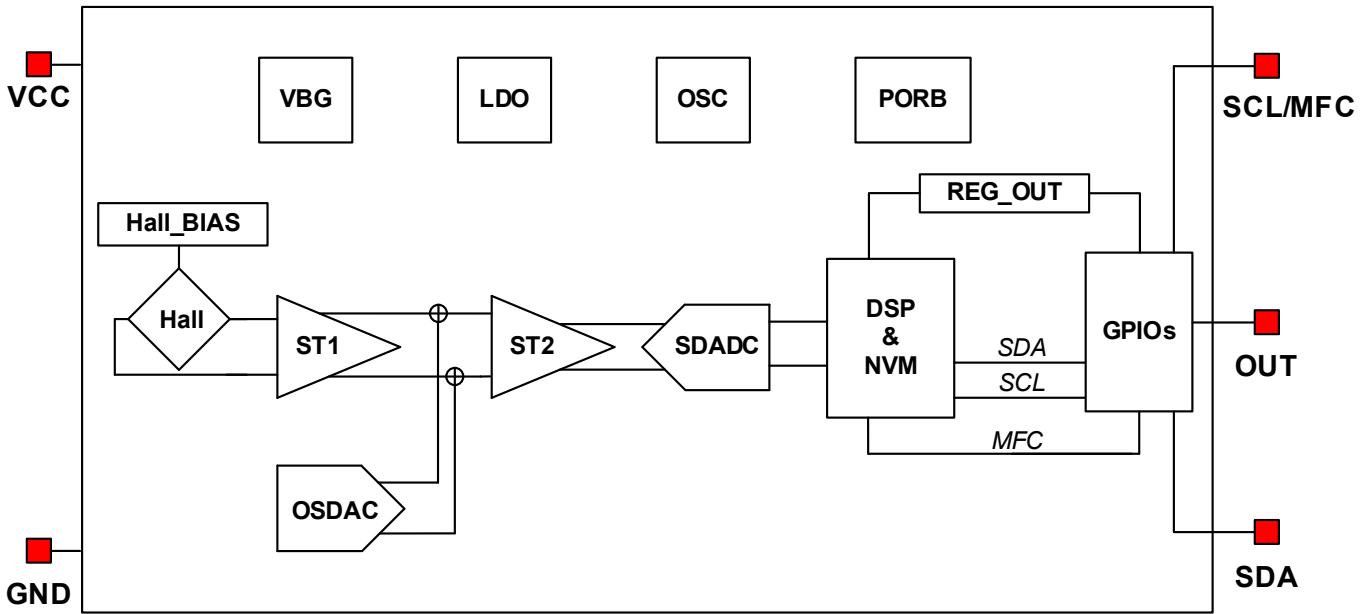


Figure.2 Functional Block Diagram

7 Typical Application Circuit

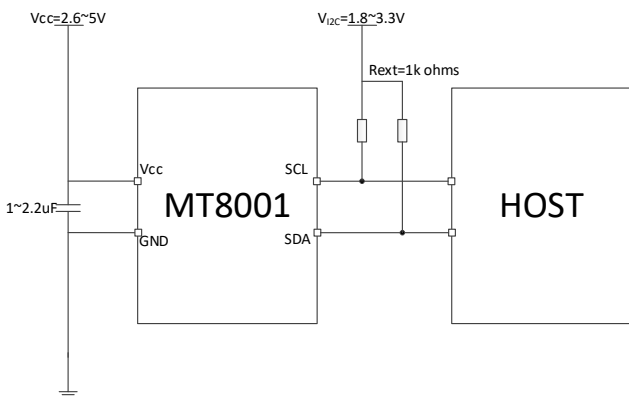


Figure.3 Application Circuit for I2C Interface

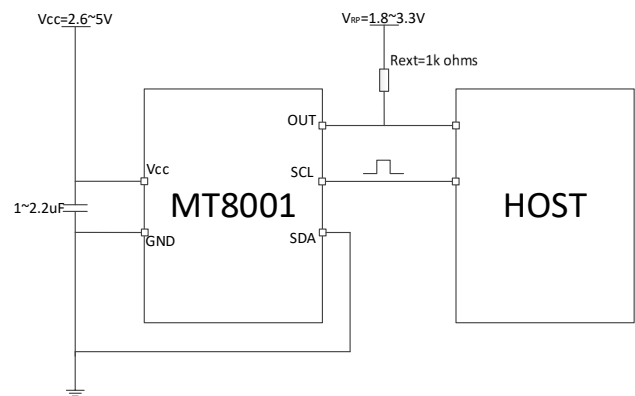


Figure.4 Application Circuit for Switch Mode
(SCL Pin Makes Self Calibration by Host)

8 Electrical and Magnetic Characteristics

8.1 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	Parameter	Min	Max	Unit
VCC	Supply Voltage	-	7	V
VOUT & VSCL & VSDA	Output & SCL & SDA Voltage	-	7	V
IOUT	Continuous Output Current	-	10	mA
TA	Operating Ambient Temperature	-20	85	°C
TS	Storage Temperature	-50	165	°C

8.2 Electrical Specifications

At $T_A = -20 \sim 85^\circ\text{C}$, $V_{CC} = 2.6\text{V} \sim 5\text{V}$ (unless otherwise specified)

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
V_{CC}	Supply Voltage	Operating	2.6	3.3	5	V
I_{CC} (Sleep)	Sleep Mode Current	$V_{CC} = 3.3\text{V}$, $T_A = 25^\circ\text{C}$	-	-	5	μA
I_{CC} (Awake)	Awake Mode Current	$V_{CC} = 3.3\text{V}$, $T_A = 25^\circ\text{C}$	-	2.8	3.5	mA
I_{CC} (SW)	Switch Mode Current	$V_{CC} = 3.3\text{V}$, $T_A = 25^\circ\text{C}$	10	-	75	μA
F_{sw}	Sampling Frequency (Switch Mode), $T_A = 25^\circ\text{C}$		10	-	75	Hz
	Sampling Frequency (I2C Interface), $T_A = 25^\circ\text{C}$		-	16	-	KHz
T_{SA}	Cycling Time of Output (Switch Mode)		13.3		100	ms
T_{Active}	Active Time of Output (Switch Mode)		-	312.5	-	μs
I_{OUT}	Digital Output Current	Pull up $> 1\text{K}\Omega$, $V_{OUT} < 0.4\text{V}$	-	-	4	mA
V_{SAT}	Digital Output Saturation Voltage	$I_{OUT} = 4\text{mA}$, $V_{OUT} = \text{Low Level}$	-	-	0.4	V
T_F	Output Fall Time	$R_L = 1\text{K}\Omega$ $C_L = 20\text{pF}$	-	-	1	μs
T_{PO}	Power on Time	$V_{CC} = 3.3\text{V}$	-	-	10	ms
V_{IL}	Input Low Voltage of SCL & SDA		-	-	0.7	V
V_{IH}	Input High Voltage of SCL & SDA		0.9	-	-	V
R_{TH}	Thermal Resistance of DFN		-	301	-	$^\circ\text{C}/\text{W}$

8.3 Magnetic Characteristics

At $T_A = -20 \sim 85^\circ\text{C}$, $V_{CC} = 2.6\text{V} \sim 5\text{V}$ (unless otherwise specified)

Symbol	Parameter	Min	Typ	Max	Unit
B	Magnetic Field (1)	-3000	-	3000	Gs
SENS	Internal Magnetic Sensitivity Option (1)	-	-	100	Code/Gs
SENS (T)	Temperature Compensation of Sensitivity	-	2000	-	ppm/ $^\circ\text{C}$
B_{off}	Offset	-	-	± 4	Gs
B_{Noise}	Noise	-	-	± 2	Gs
LIN	Linearity	-	-	1.5	%
Code_OUT	Hall Output	-	12	-	bit

Note:

(1) The field range & the sensitivity can be adjusted through the I2C interface, refer to Figure.6

8.4 ESD Ratings

Symbol	Reference	Value	Unit	
V _{ESD}	Human-body model (HBM)	AEC-Q100-002	±4000	V
	Charged-device model (CDM)	AEC-Q100-011	±1000	V

9 I2C Interface

9.1 Timing Requirement

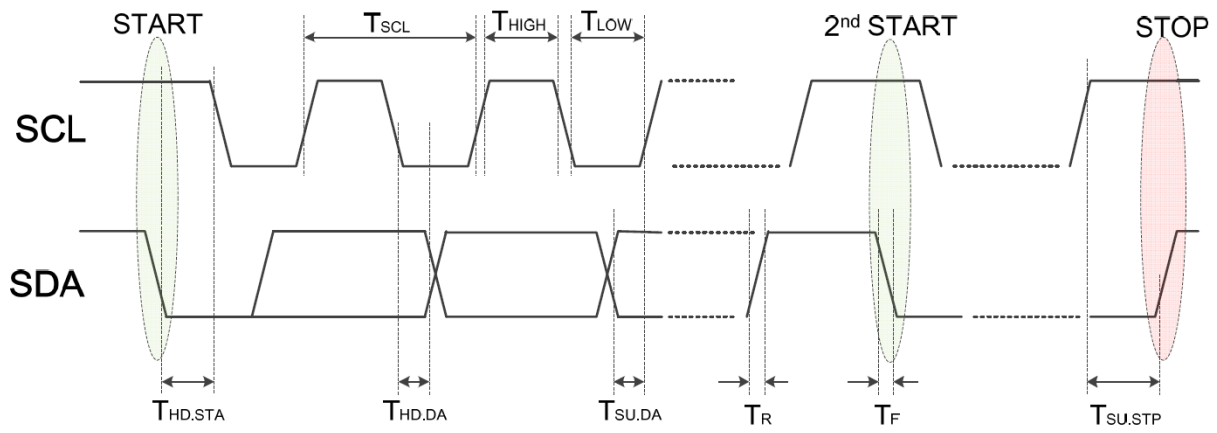


Figure.5 I2C Timing Diagram

Parameter	Description	Min.	Max.	Unit
T_{SCL}	SCL Clock Period	1	-	μ s
$T_{HD.STA}$	Hold Time of 'START'	250	-	ns
T_{LOW}	Low Phase of SCL	250	-	ns
T_{HIGH}	High Phase of SCL	250	-	ns
$T_{SU.DA}$	Setup Time of SDA	100	-	ns
$T_{HD.DA}$	Hold Time of SDA	50	-	ns
T_R	Rising Time of SDA/SCL	-	150	ns
T_F	Falling Time of SDA/SCL	-	150	ns
$T_{SU.STP}$	Setup Time of 'Stop'	250	-	ns

9.2 I²C Timing Diagram

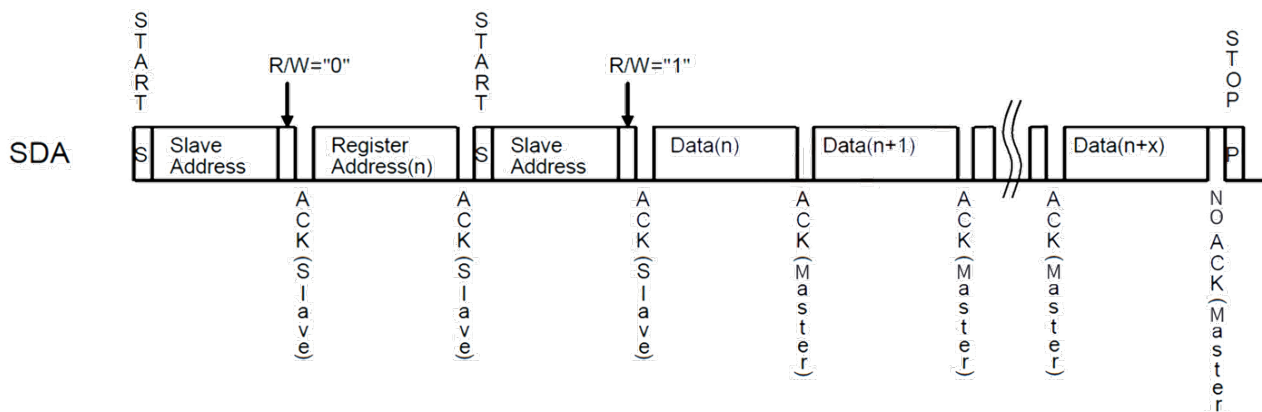


Figure.6 I2C Timing Diagram(2)

9.3 Register Map

Name	Description	Addr.	R/W	DATA								Default	
				Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0		
SOFT_RST	Soft Reset	0x0A	R/W	SOFT _ RST									
Mode	Active/Sleep selection	0x0C	R/W					Mode					0x00
Code_CIC	Primary amplification of magnetic field code	0x44	R	Code_CIC[15:8]									
		0x45	R	Code_CIC[7:0]									
Code_OUT	Secondary amplification of magnetic field code	0x46	R					Code_OUT[11:8]				0xFFC~ 0x004	
		0x47	R	Code_OUT[7:0]									
USER_ID	Free use	0x50	R/W	USER_ID[7:0]									
SLV_ADDR	Slave ID selection	0x51	R/W					SLV_ADDR[1:0]					0x13
CTH_H	Magnetic field code threshold high setting	0x53	R/W					CTH_H[11:8]					
		0x54	R/W	CTH_H[7:0]									
CTH_L	Magnetic field code threshold low setting	0x55	R/W					CTH_L[11:8]					
		0x56	R/W	CTH_L[7:0]									
ADC_OS	Secondary magnetic field code offset setting	0x57	R/W	ADC_OS[15:8]									
		0x58	R/W	ADC_OS[7:0]									
Sign & DAC_GAIN	Primary magnetic field code gain setting	0x5B	R/W					Sign	DAC_GAIN[2:0]			0x00	
ADC_GAIN	Secondary magnetic field code gain setting	0x5C	R/W							ADC_GAIN[9:8]		0x30~ 0x60	
		0x5D	R/W	ADC_GAIN[7:0]									
DAC_OS	Primary magnetic field code gain setting	0x5F	R/W			DAC_OS[5:0]							

Note: Default value refer to MT8001DT1616

9.4 Slave Address

The I2C interface should support up to 1MHz of clock. 4 slave addresses are selectable by setting register SLV_ADDR. The default slave address (8-bit) is 0x12 (write) and 0x13 (read).

Name	Addr.	R/W	DATA								
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
SLV_ADDR	0x51	R/W						SLV_ADDR[1:0]			

Slave address can be modified based on the below table

SLV_ADDR	W	R
0 (Default)	0x12	0x13
1	0x24	0x25
2	0x3A	0x3B
3	0x54	0x55

9.5 Mode Control

Name	Addr.	R/W	DATA							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Mode	0x0C	R/W					Mode			

Mode: Mode Control

0: Active Mode

1: Sleep Mode

9.6 Code_OUT

Name	Addr.	R/W	DATA							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Code_CIC	0x44	R	Code_CIC[15:8]							
	0x45	R	Code_CIC[7:0]							
Code_OUT	0x46	R					Code_OUT[11:8]			
	0x47	R	Code_OUT[7:0]							
CTH_H	0x53	R/W					CTH_H[11:8]			
	0x54	R/W	CTH_H[7:0]							
CTH_L	0x55	R/W					CTH_L[11:8]			
	0x56	R/W	CTH_L[7:0]							
ADC_OS	0x57	R/W	ADC_OS[15:8]							
	0x58	R/W	ADC_OS[7:0]							
DAC_GAIN	0x5B	R/W					Sign	DAC_GAIN[2:0]		
ADC_GAIN	0x5C	R/W							ADC_GAIN[9:8]	
	0x5D	R/W	ADC_GAIN[7:0]							
DAC_OS	0x5F	R/W			DAC_OS[5:0]					

Code_OUT value can be adjusted by all kinds of gain & offset based on below formula, B is magnetic field (Gs)

$$\text{Code_OUT} = (\text{Code_CIC} + \text{ADC_OS}) * \text{ADC_GAIN} / 2^8$$

$$\text{Code_CIC} = (B * 3.5e - 4 + \text{DAC_OS} / 2^6 * 2.4) * \text{DAC_GAIN} / 3.6 * 2^{16}$$

Sign: Define the positive & negative of the gain, the default value is 0, means negative. And 1 means positive

Code_OUT、Code_CIC、ADC_OS、ADC_GAIN、DAC_OS value is decimal value, DAC_GAIN value is obtained by looking up table as below:

DAC_GAIN	Value	DAC_GAIN	Value
000	1.2	100	3.0
001	1.5	101	3.8
010	1.9	110	4.8
011	2.4	111	6.0

10 Product Specification

10.1 Type 0 (Default)

Part Number MT8001 DT - 1616

①
②
③

① Series Name

② Package Type

Type	Package Type
DT	DFN-5L

③ Package Size

Type	Package Size
1616	1.6mm*1.6mm

10.2 Type 1 (I2C Interface)

Part Number MT8001 DT - 1616 - 200 X

①
②
③
④
⑤

④ Magnetic Field Range

Type	Magnetic Field Range
100	Range=-100Gs~100Gs
200	Range=-200Gs~200Gs
.....
1K	Range=-1000Gs~1000Gs

⑤ Slave Address

Type	Slave Address
A	Slave ID: 0x12(write)
B	Slave ID: 0x24(write)
C	Slave ID: 0x3A(write)
D	Slave ID: 0x54(write)

10.3 Type 2 (Switch Mode)

Part Number MT8001 DT - 1616 - X X X X

①
②
③
④
⑤
⑥
⑦

④ Gain Setting

Type	Gain Setting
A	DAC_GAIN=1.2, ADC_GAIN=1
.....

⑥ Hysteresis Setting

Type	Hysteresis Setting
A	CTH_H=50, CTH_L=25
.....

⑤ Offset Setting

Type	Offset Setting
A	DAC_OS=1000, ADC_OS=500
.....

⑦ Frequency Setting

Type	Frequency Setting
A	Switch Frequency=10Hz
.....
Z	Switch Frequency=75Hz

10.4 Key Parameter Description

10.4.1 Gain Description

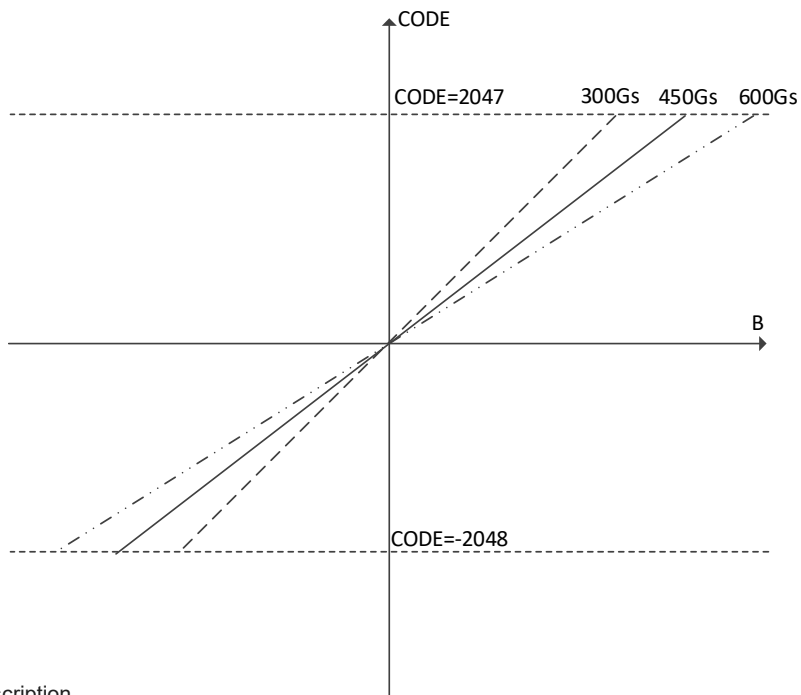


Figure.7 Gain Description

10.4.2 Offset Description

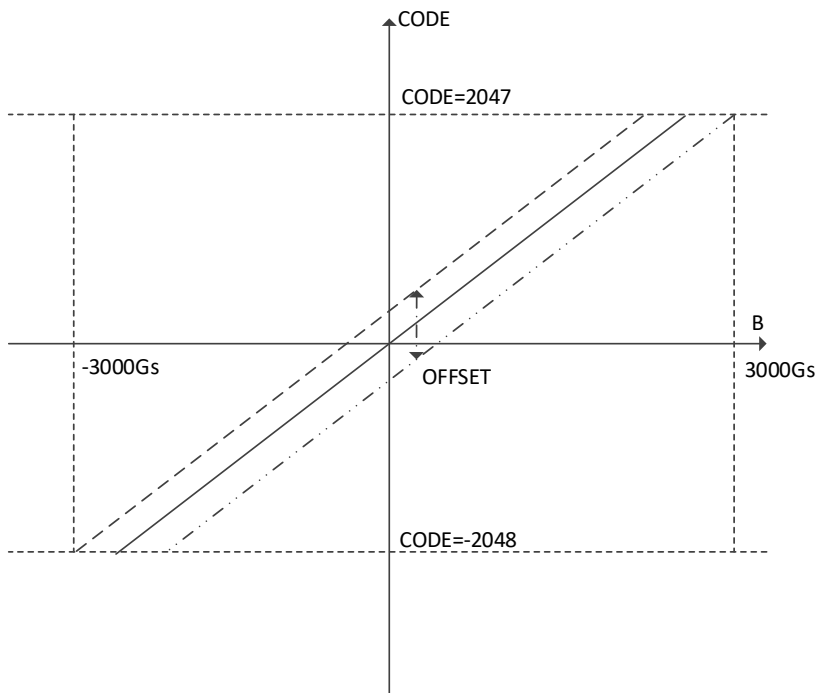


Figure.8 Offset Description

10.4.3 Hysteresis Description (CTH_H & CTH_L)

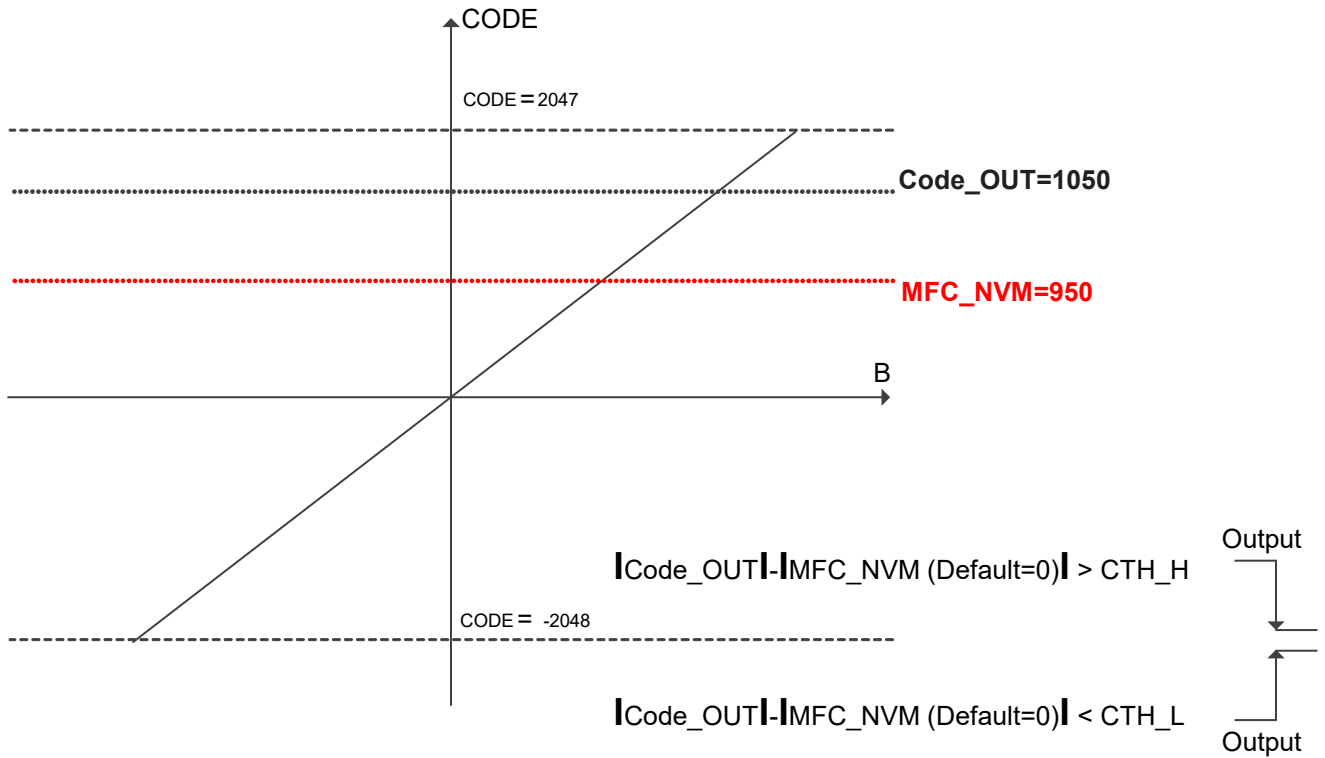


Figure.9 Hysteresis Description

Hysteresis Description :

Code_DIFF = $|Code_OUT| - |MFC_NVM|$ (Default=0, it can be updated by I2C or CLK PIN pull to high), refer to Figure.13

When the Code_DIFF > CTH_H, the output pin changes from high level to low level

When the Code_DIFF < CTH_L, the output pin changes from low level to high level

10.5 Characteristic Performance

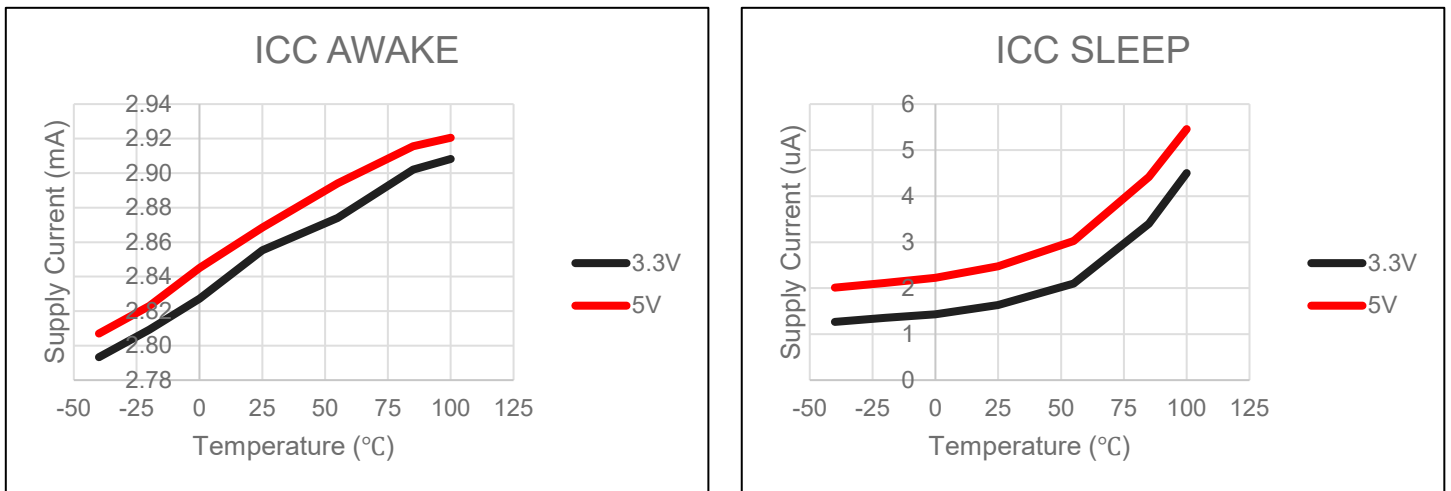


Figure.10 Supply Current vs. Temperature

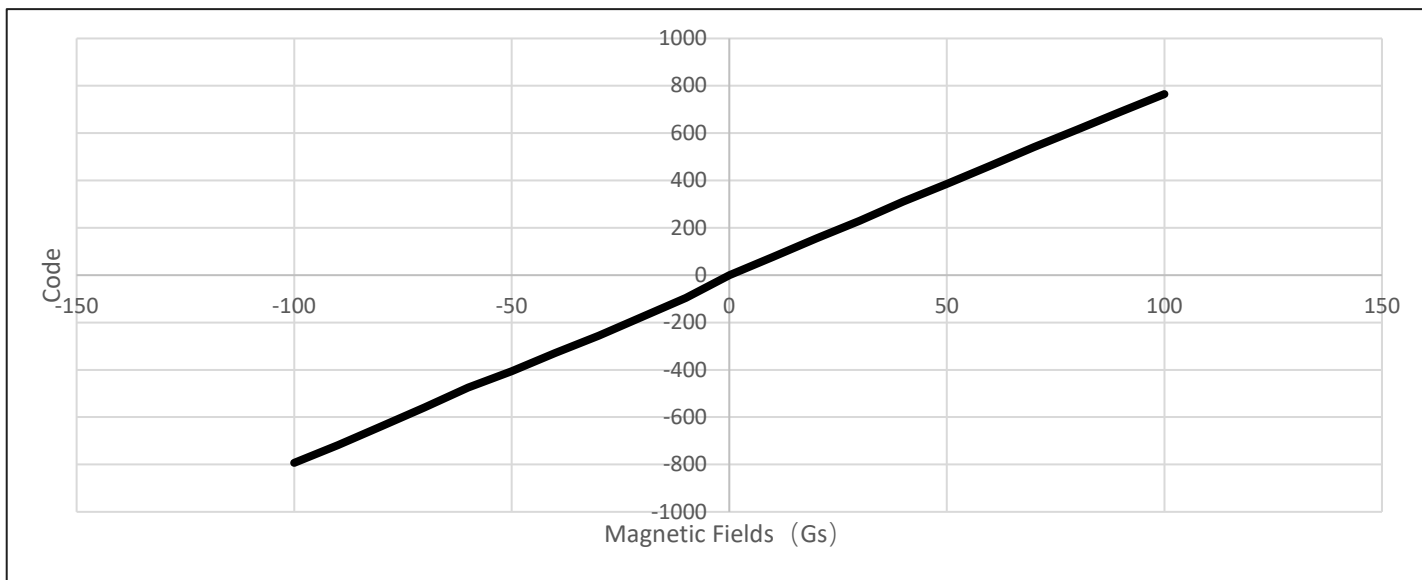


Figure.11 Code Out vs. Magnetic Fields @Vcc=3.3V, Sensitivity= 8code/Gs @ room temperature

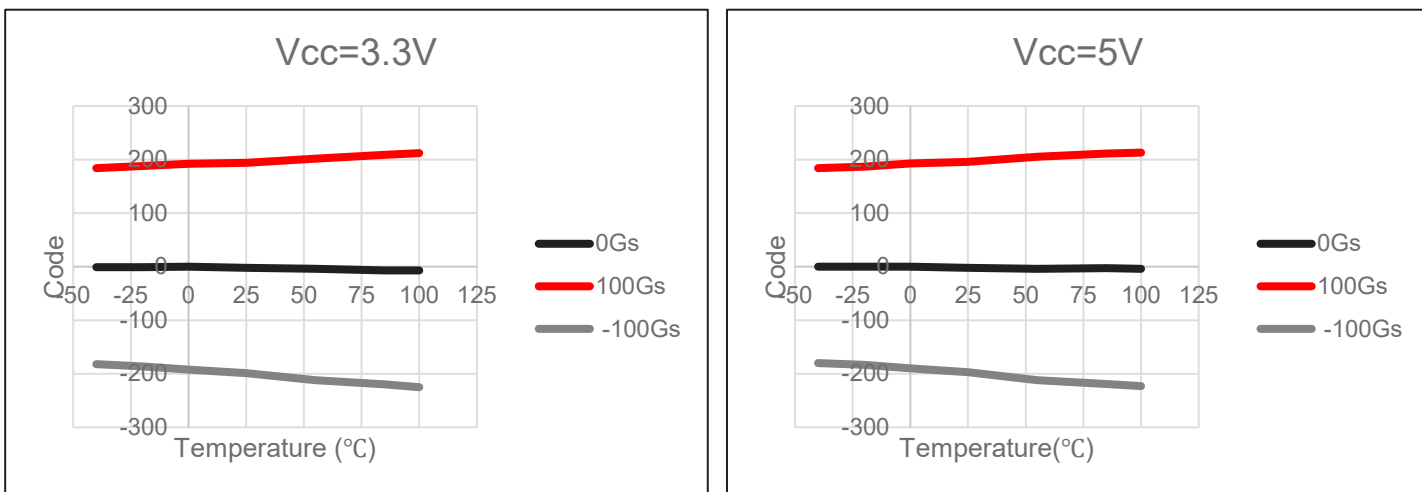


Figure.12 Code Out vs. Temperature , Sensitivity=2.0code/Gs @ room temperature

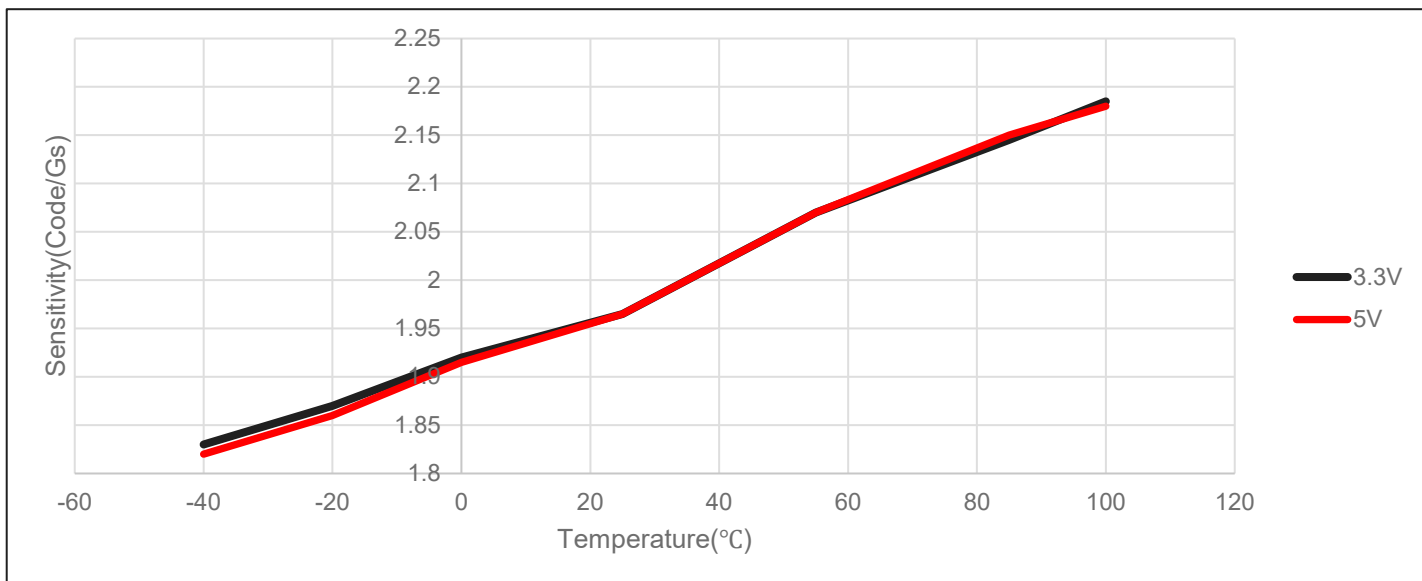


Figure.13 Sensitivity vs. Temperature , Sensitivity=2.0code/Gs @ room temperature

10.6 Function Description of Switch Mode

Refer to Figure.4, pull down the SDA to the GND firstly, then power on the chip, the chip will turn into the switch mode. And pull up the MFC_EN (CLK) can make the chip updating the MFC_NVM. That will help the system adjust the magnetic field deviation caused by the errors of different structures. The pulse of the MFC_EN must be longer than T_{SA} .

Code_DIFF > CTH_H, output=Low

Code_DIFF < CTH_L, output=high

Code_DIFF = |Code_OUT| - |MFC_NVM|

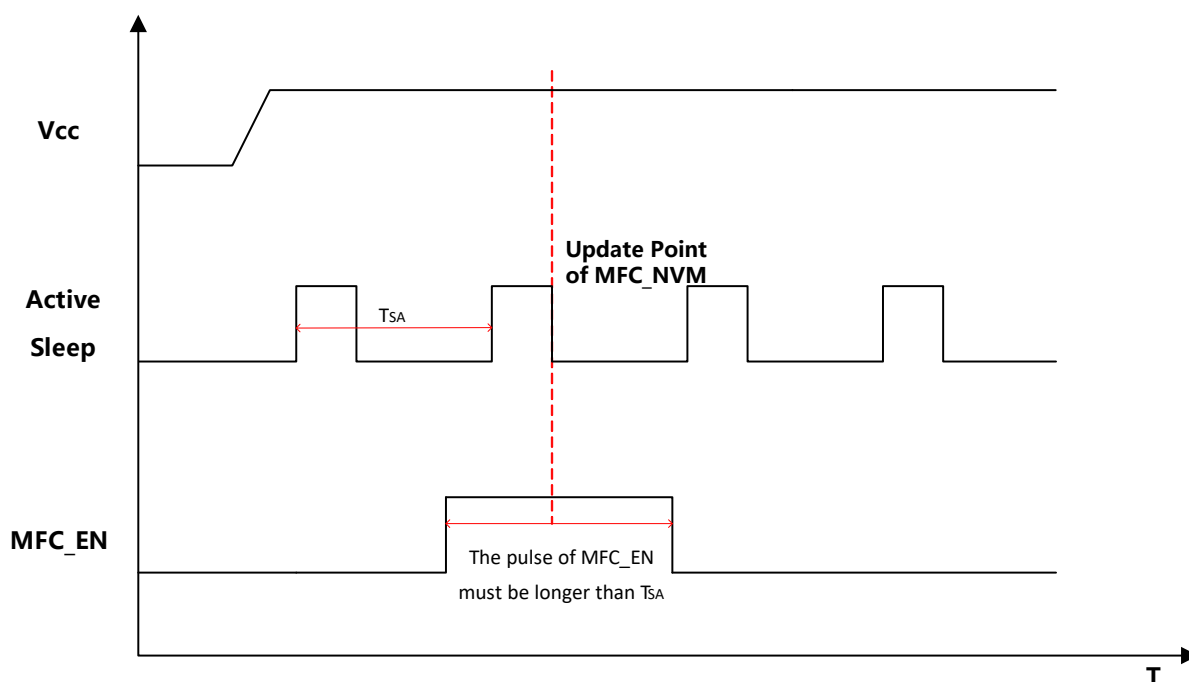


Figure.14 Switch Mode Function Description (SDA=Low)

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

11.1 DFN1616 Package Information

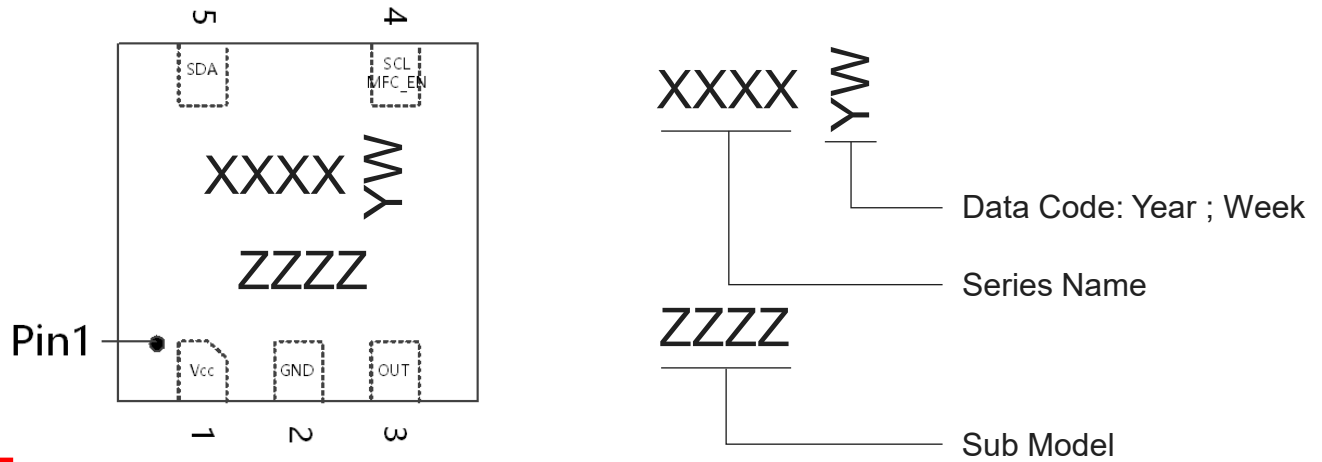


Figure.15 DFN1616 Chip Marking Spec

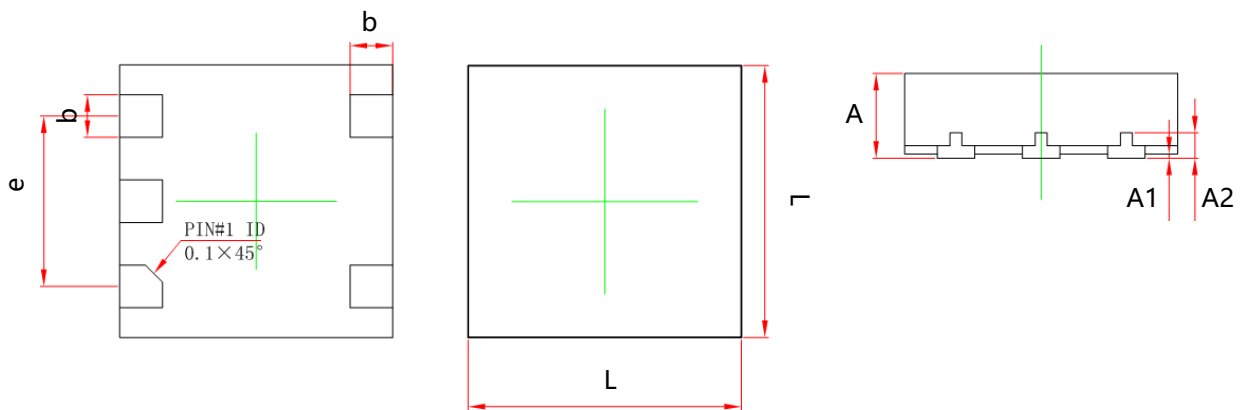


Figure.16 DFN1616 Package Drawing

Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	0.450	0.550	0.018	0.022
A1	0.000	0.050	0.000	0.002
A2	0.150 TYP		0.006 TYP	
L	1.550	1.650	0.061	0.065
b	0.200	0.300	0.008	0.012
e	1.000 TYP		0.039 TYP	

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