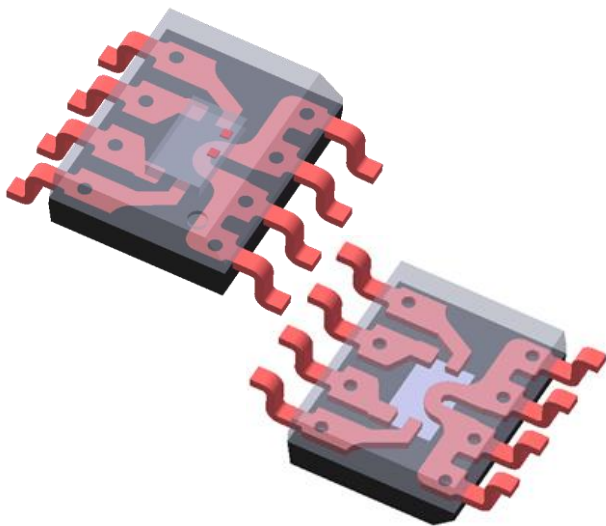


1 Product Description

The MagnTek® MT9223 product series is a fully integrated Hall Effect-based isolated linear current sensor device family designed for AC or DC current sensing in industrial, commercial, and communications systems. Each of the MT9223 consists of a precise, low-offset, linear Hall circuit with a low-resistance current conductor path located near the surface of the die. Applied current flowing through this low-resistance current conductor path generates a magnetic field that the Hall IC converts into a proportional voltage. The current is sensed differentially in order to reject common-mode fields, improving accuracy in magnetically noisy environments. Device accuracy is optimized through the close proximity of the magnetic field to the Hall transducer.

A precise, proportional voltage is provided by the low-offset, chopper-stabilized BCD Hall IC, which has been accurately calibrated when it is manufactured. The output of the device has a positive slope (>VOQ) when an increasing current flows through the primary current conduction path (from pins 1 and 2, to pins 3 and 4). The internal resistance of this conductive path is 1.2 mΩ typical, providing low-power loss. The terminals of the conductive path are electrically isolated from the signal leads (pins 5 through 8). This allows the MT9223 current sensor IC to be used in high-side current sense applications without use other costly isolation techniques.

The MT9223 family provides SOP-8 package to customers, The package is RoHS compliant.



Not to scale

2 Features

- ±1.9% Typical Total Output Error
- ±0.5% Typical Linearity Over Temperature
- Fast Output Response Time: 4 μs (typ.)
- 150kHz Signal Bandwidth
- 5.0V Single Supply Operation
- -40°C~125°C Operating Temperature
- Primary Conductor Resistance
---1.2mΩ
- Sensing Current Range: (AC or DC)
---±20A, ±25A, ±30A, ±40A, ±50A
---+20A, +30A, +35A
- Output Voltage Proportional to AC or DC Current
- Ratiometric Output from Supply Voltage
- Extremely Stable Quiescent Output Voltage
- Low-Noise Analog Signal Path
- Device Bandwidth is Set via FILTER Pin
- Near Zero Magnetic Hysteresis
- Isolation Voltage:
---2.4kVrms Dielectric Surge Isolation
- Package Option:
---SOP-8
- RoHS Compliant: (EU)2015/863

3 Applications

- Low-power inverter current sensing
- Motor phase and rail current sensing
- PV String Inverters
- Chargers and Converters
- Switching Power Supplies
- Overcurrent Protection

4 Product Overview of MT9223

| Part No. | Description |
|----------|----------------------------------|
| MT9223CT | SOP-8, tape & reel (3000pcs/bag) |

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Reversion History

| | | |
|---|--------------------|---------------------------------|
| 1 | Originally Version | |
| 2 | 0.2 Version | Update Application Figure |
| 3 | 0.3 Version | Update Absolute Maximum Ratings |

5 Functional Block Diagram

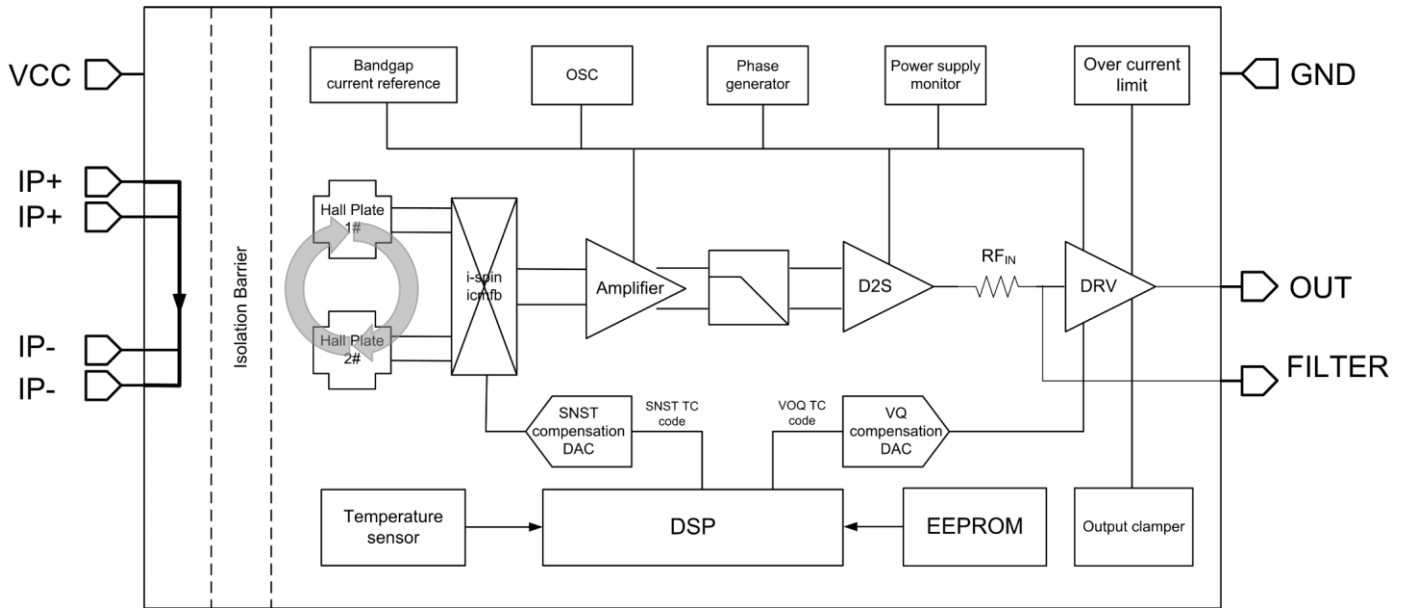


Figure.1 Functional Block Diagram

6 Pin Configuration and Functions

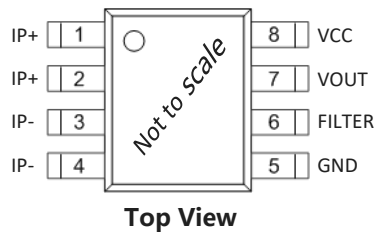


Figure.2 Pin Configuration & Functions (SOP-8)

| No. | Name | Description |
|------|--------|-----------------------------|
| 1, 2 | IP+ | Input Current Positive Pin |
| 3, 4 | IP- | Input Current Negative Pin |
| 5 | GND | Signal Ground |
| 6 | FILTER | Filter Pin to Set Bandwidth |
| 7 | VOUT | Analog Output Signal |
| 8 | VCC | Power Supply |

7 Naming Specification



① Series Name

② Package Type

| Type | Package Type |
|------|--------------|
| CT | SOP-8 |

③ Input Current Range

| Type | Input Current Range |
|------|-------------------------------|
| 20 | Full scale sensing range: 20A |
| 25 | Full scale sensing range: 25A |
| 30 | Full scale sensing range: 30A |
| 35 | Full scale sensing range: 35A |
| 40 | Full scale sensing range: 40A |
| 50 | Full scale sensing range: 50A |

④ Current Polarity

| Type | Current Polarity |
|------|-----------------------------|
| B | Bidirectional---AC Current |
| U | Unidirectional---DC Current |

⑤ Output Mode

| Type | Output Mode |
|------|-------------------|
| R | Ratiometry output |

⑥ Power Supply

| Type | Power Supply |
|------|--------------|
| 5 | VCC=5V |

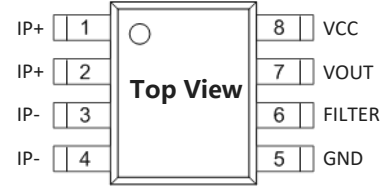
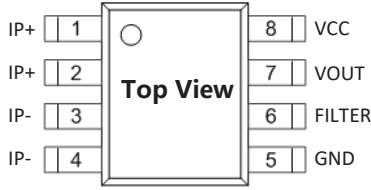
8 Selection Guide

| Ordering Part Number | Current Range (A) | VCC (V) | Sensitivity (mV/A) | Package | Qty per Reel (pcs) |
|----------------------|-------------------|---------|--------------------|---------|--------------------|
| MT9223CT-20UR5 | +20 | 5 | 200 | SOP-8 | 3000 |
| MT9223CT-30UR5 | +30 | 5 | 133.3 | SOP-8 | 3000 |
| MT9223CT-35UR5 | +35 | 5 | 114.3 | SOP-8 | 3000 |
| MT9223CT-20BR5 | ±20 | 5 | 100 | SOP-8 | 3000 |
| MT9223CT-25BR5 | ±25 | 5 | 80 | SOP-8 | 3000 |
| MT9223CT-30BR5 | ±30 | 5 | 66.6 | SOP-8 | 3000 |
| MT9223CT-40BR5 | ±40 | 5 | 50 | SOP-8 | 3000 |
| MT9223CT-50BR5 | ±50 | 5 | 40 | SOP-8 | 3000 |

9 Output Voltage vs. Input Current

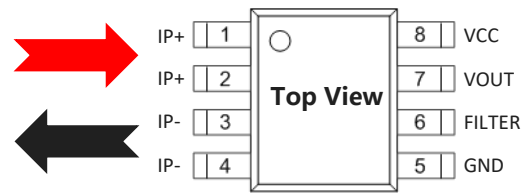
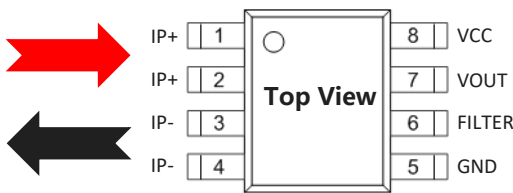
MT9223CT – xxUR5

MT9223CT – xxBR5



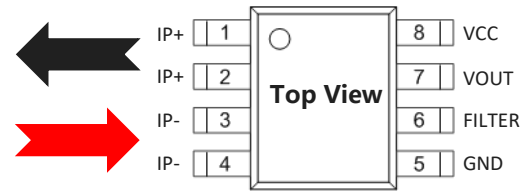
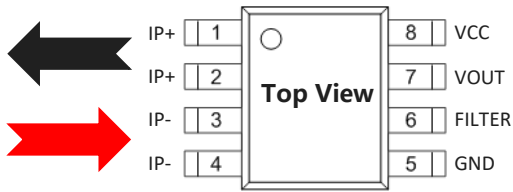
IP = 0A
Vout=0.5V

IP = 0A
Vout=2.5V



IP > 0A
Vout=0.5~4.5V

IP > 0A
Vout=2.5~4.5V



IP < 0A
Vout=0.5V~0V

IP < 0A
Vout=2.5~0.5V

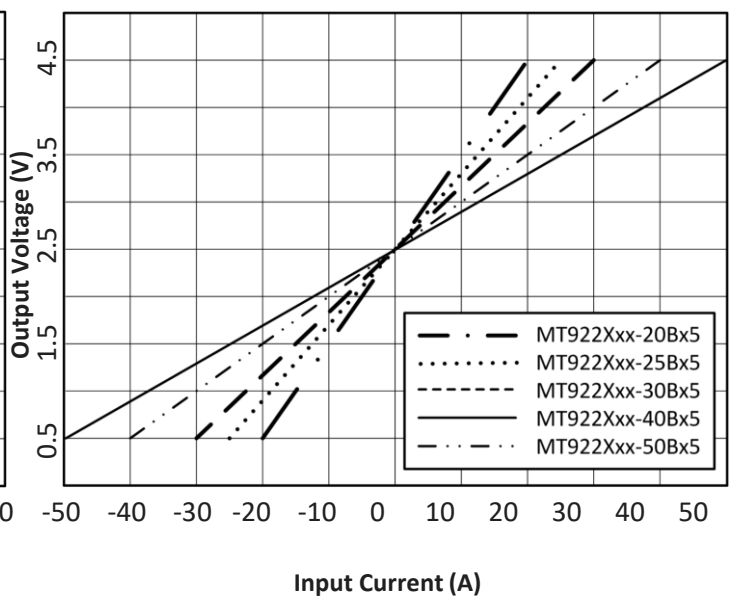
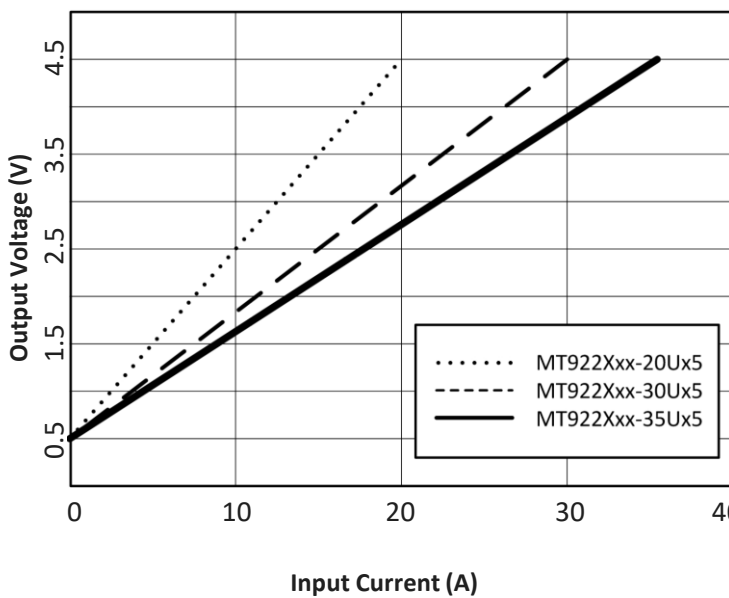


Figure.3 Output Voltage vs. Input Current

10 Typical Application Circuit

The typical application circuits of MT9223 series products include a bypass capacitor (**CBYPASS capacitor between VCC and GND is necessary**) and a filter capacitor as an additional external components. On the input side, pins 1 and 2 are shorted together, pins 3 and 4 are shorted together. The analog signal output is measured directly from the VOUT pin. The signal is proportional to the IP of the primary sensing current of AC or DC within the specified measurement range. **The FILTER pin can be used to reduce bandwidth to optimize noise performance, but at the same time proportionally increase response time.**

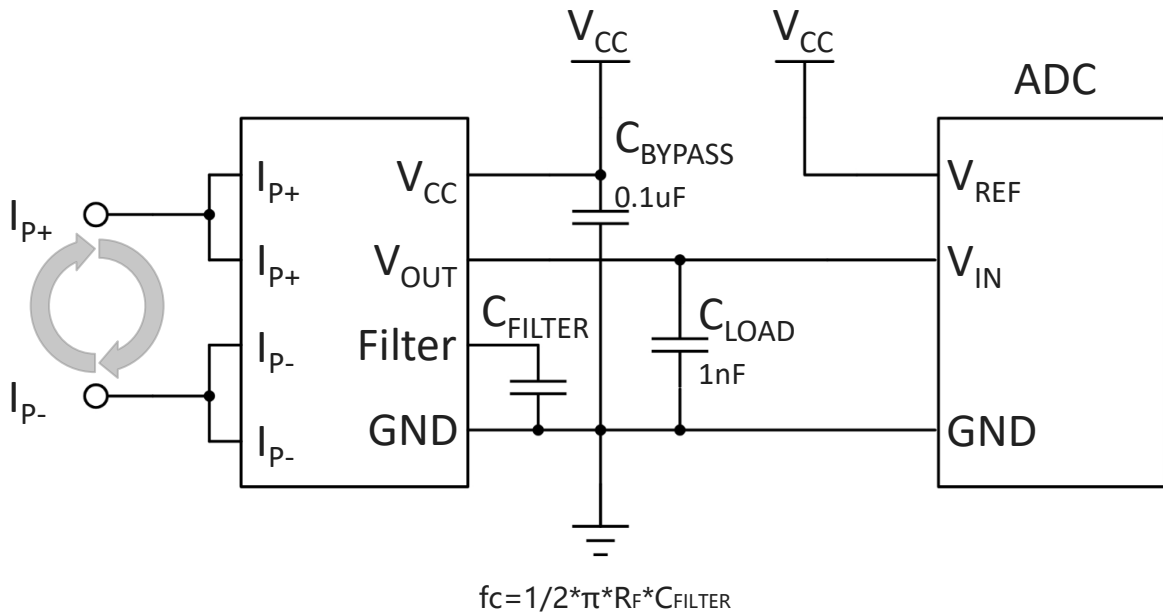


Figure.4 Typical Application Circuit

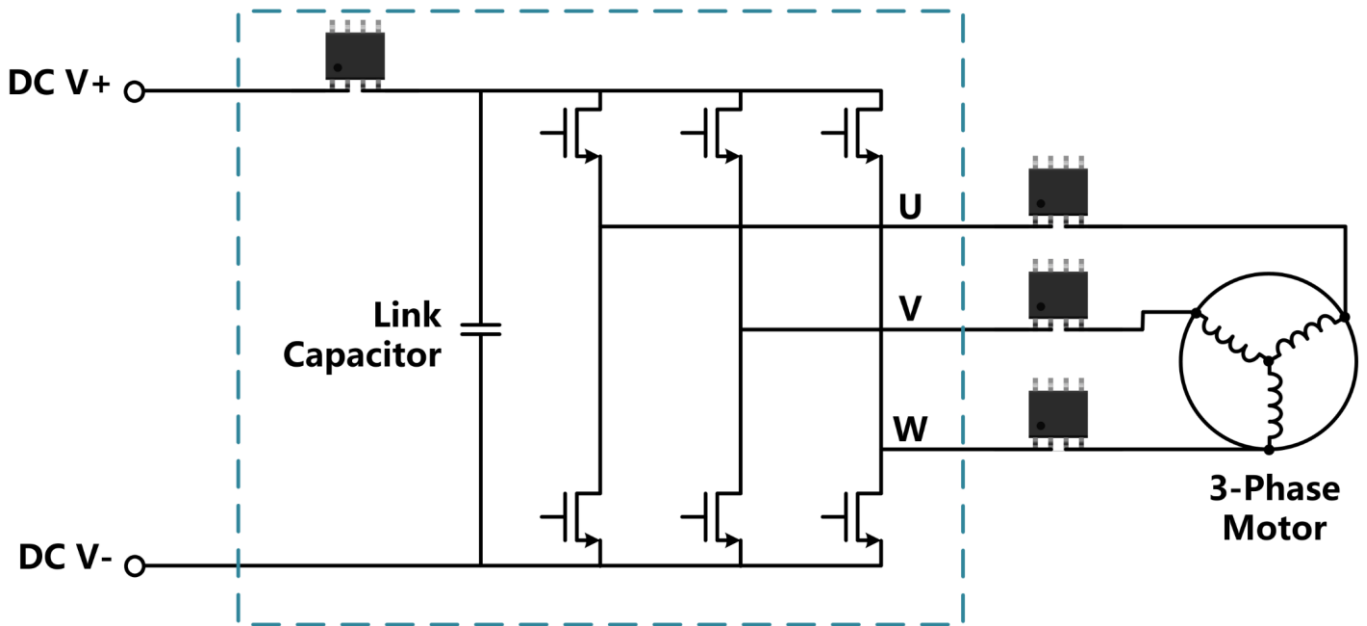


Figure.5 Simplified Three-Phase Inverter Schematic

11 Electrical Magnetic Characteristics

11.1 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 |
|--------------|-------------------------------|------|---------|-------|
| VCC | Supply Voltage | - | 6 | V |
| VRCC | Reverse Battery Voltage | -0.1 | - | V |
| VOUT | Output Voltage | - | VCC+0.5 | V |
| VROUT | Reverse Output Voltage | -0.1 | - | V |
| IOUT(source) | Continuous Output Current | - | 80 | mA |
| IOUT(sink) | Continuous Output Current | - | 40 | mA |
| TA | Operating Ambient Temperature | -40 | 125 | °C |
| TS | Storage Temperature | -50 | 150 | °C |
| TJ | Junction Temperature | - | 165 | °C |

11.2 Isolation and Package Characteristics

| Symbol | Parameters | Test Conditions | Value | Units |
|--------------------|--|--|-------|-------|
| V _{SURGE} | Dielectric Surge Strength Test Voltage | Tested ±5 pulses at 30 seconds in compliance to IEC 61000-4-5 1.2 / 50 μs (width). | 6000 | V |
| V _{ISO} | Dielectric Strength Test Voltage | Test method per UL standard 60950-1 (edition 2). V _{TEST} = V _{ISO} , t = 60 s (qualification); V _{TEST} = 1.2 × V _{ISO} , t = 1 s (100% production) | 2400 | Vrms |
| D _{CL} | External Clearance | Measured from input terminals to output terminals, shortest distance through air. | 4 | mm |
| D _{CR} | External Creepage | Measured from input terminals to output terminals, shortest distance path along body. | 4 | mm |

11.3 ESD Ratings

| Symbol | Parameters | Reference | Values | Unit |
|--------|----------------------------|--------------|------------|-------|
| VESD | Human-body model (HBM) | AEC-Q100-002 | Class IIIA | Grade |
| | Charged-device model (CDM) | AEC-Q100-011 | Class C3 | Grade |
| | Latch up | AEC-Q100-004 | Class IIA | Grade |

11.4 Electrical Specifications

At TA = -40~125 °C, VCC=5V (unless otherwise specified)

| Symbol | Parameters | Test Condition | Min | Typ | Max | Unit |
|-----------|---|--|---------|------|-----|--------|
| VCC | Supply Voltage | - | 4.5 | 5 | 5.5 | V |
| ICC | Supply Current | TA = 25°C | - | 14 | 20 | mA |
| RIP | Primary Conductor Resistance | TA = 25°C | - | 1.2 | - | mΩ |
| BW | Internal Bandwidth | Small signal -3 dB; CL = 1 nF | - | 150 | - | KHz |
| TPO | Power on time | TA = 25°C, CL = 1nF, IP=IPR(max) applied | - | 190 | - | us |
| TR | Rise time | IP = IPR(max), A = 25°C, CL = 1nF | - | 3 | - | us |
| TPD | Propagation Delay | IP = IPR(max), TA = 25°C, CL = 1nF | - | 2 | - | us |
| TRESP | Response Time | IP = IPR(max), TA = 25°C, CL = 1nF | - | 4 | 5 | us |
| VOL | Analog Output Low Saturation Level | RL>=4.7KΩ | - | - | 0.3 | V |
| VOH | Analog Output High Saturation Level | RL>=4.7KΩ | VCC-0.3 | - | - | V |
| CL | Output CAP Load | OUT to GND | - | 1 | 10 | nF |
| ROUT | DC Output resistance | | - | 5 | - | Ω |
| RL | Output RES Load | Pull-down to Ground | 4.7 | - | - | KΩ |
| | | Pull-up to VCC | 4.7 | - | - | KΩ |
| RF(int) | Internal filter resistance | | - | 1.8 | - | KΩ |
| IND | Noise Density | Input-referenced noise density; TA = 25°C, CL = 1 nF | - | 120 | - | uA/√Hz |
| ELIN | Nonlinearity error | Through full range of IP | -1.5 | - | 1.5 | % |
| ERAT_SNST | Ratiometry Sensitivity Error | VCC = 4.5 to 5.5 V, TA = 25°C | - | ±1.5 | - | % |
| ERAT_VOQ | Ratiometry Quiescent Voltage Output Error | VCC = 4.5 to 5.5 V, TA = 25°C | - | ±1 | - | % |

* Device may be operated at higher primary current levels, ambient temperatures, and internal leadframe temperatures, provided the Maximum Junction Temperature, is not exceeded.

Continued on the next page...

Electrical Specifications (continued)At $T_A = -40 \sim 125^\circ\text{C}$, $V_{CC} = 5\text{V}$ (unless otherwise specified)

| Symbol | Parameters | Test Condition | Min | Typ | Max | Unit |
|-------------|--------------------------------------|--|------|---------|------|------|
| CMFRR | Common Mode Field Rejection Ratio | Uniform external magnetic field | - | 40 | - | dB |
| SNST(match) | Hall Plate Sensitivity Matching | $T_A = 25^\circ\text{C}$ | | ± 1 | - | % |
| VPORH | Power-On Reset High Voltage | $T_A = 25^\circ\text{C}$, VCC rising | 3.75 | 4 | 4.25 | V |
| VPORL | Power-On Reset Low Voltage | $T_A = 25^\circ\text{C}$, VCC falling | - | 3.5 | - | V |
| VPORHYS | Power-On Reset Hysteresis | $T_A = 25^\circ\text{C}$ | - | 0.5 | - | V |
| TPORR | Power-On Reset Release Time | $T_A = 25^\circ\text{C}$, VCC rising | - | 30 | - | us |
| TPORA | Power-On Reset Analog Delay | $T_A = 25^\circ\text{C}$, VCC rising | - | 5 | - | us |
| ISCLP | Source Current of Over-Current-Limit | - | - | 80 | - | mA |
| ISCLN | Sink Current of Over-Current-Limit | - | - | 40 | - | mA |
| TSCLD | Detect Time for Over-Current-Limit | $T_A = 25^\circ\text{C}$, $I_{OUT} > I_{SCLP}$ or $I_{OUT} < I_{SCLN}$ | - | 7 | - | us |
| TSCLR | Release Time for Over-Current-Limit | $T_A = 25^\circ\text{C}$ | - | 0.62 | - | ms |

* Device may be operated at higher primary current levels, ambient temperatures, and internal leadframe temperatures, provided the Maximum Junction Temperature, is not exceeded.

11.5 Accuracy SpecificationsMT9223CT-20UR5 At $T_A = -40 \sim 125^\circ\text{C}$, $V_{CC} = 5\text{V}$ (unless otherwise specified)

| Symbol | Parameters | Test Condition | Min | Typ | Max | Unit |
|--------|-------------------------------|--|------|---------------------|-----|------|
| IPR | Optimized Input Current Range | | 0 | - | 20 | A |
| SNST | Sensitivity | $0\text{A} \leq I_P \leq 20\text{A}$ | - | 200 | - | mV/A |
| VOQ | Zero-Current Output Voltage | | - | $V_{CC} \times 0.1$ | - | V |
| VOE | Zero-Current Output Error | $I_P = 0\text{A}$, $T_A = 25^\circ\text{C}$ | -10 | - | 10 | mV |
| | | $I_P = 0\text{A}$, $T_A = -40^\circ\text{C}$ to 25°C | -25 | - | 25 | mV |
| | | $I_P = 0\text{A}$, $T_A = 25^\circ\text{C}$ to 125°C | -25 | - | 25 | mV |
| ESNST | Sensitivity Error | $I_P = 20\text{A}$, $T_A = 25^\circ\text{C}$ | -1.5 | - | 1.5 | % |
| | | $I_P = 20\text{A}$, $T_A = -40^\circ\text{C}$ to 25°C | -2.5 | - | 2.5 | % |
| | | $I_P = 20\text{A}$, $T_A = 25^\circ\text{C}$ to 125°C | -2.5 | - | 2.5 | % |
| ETOT | Total Output Error | $I_P = 20\text{A}$, $T_A = 25^\circ\text{C}$ | -1.9 | - | 1.9 | % |
| | | $I_P = 20\text{A}$, $T_A = -40^\circ\text{C}$ to 25°C | -3.5 | - | 3.5 | % |
| | | $I_P = 20\text{A}$, $T_A = 25^\circ\text{C}$ to 125°C | -3.5 | - | 3.5 | % |

* Device may be operated at higher primary current levels, ambient temperatures, and internal leadframe temperatures, provided the Maximum Junction Temperature, is not exceeded.

MT9223CT-20BR5 At $T_A = -40 \sim 125^\circ\text{C}$, $V_{CC} = 5\text{V}$ (unless otherwise specified)

| Symbol | Parameters | Test Condition | Min | Typ | Max | Unit |
|--------|-------------------------------|---|------|---------------------|-----|------|
| IPR | Optimized Input Current Range | | -20 | - | 20 | A |
| SNST | Sensitivity | $-20\text{A} \leq I_P \leq 20\text{A}$ | - | 100 | - | mV/A |
| VOQ | Zero-Current Output Voltage | | - | $V_{CC} \times 0.5$ | - | V |
| VOE | Zero-Current Output Error | $I_P = 0\text{ A}, T_A = 25^\circ\text{C}$ | -10 | - | 10 | mV |
| | | $I_P = 0\text{ A}, T_A = -40^\circ\text{C}$ to 25°C | -25 | - | 25 | mV |
| | | $I_P = 0\text{ A}, T_A = 25^\circ\text{C}$ to 125°C | -25 | - | 25 | mV |
| ESNST | Sensitivity Error | $I_P = 20\text{A}, T_A = 25^\circ\text{C}$ | -1.5 | - | 1.5 | % |
| | | $I_P = 20\text{A}, T_A = -40^\circ\text{C}$ to 25°C | -2.5 | - | 2.5 | % |
| | | $I_P = 20\text{A}, T_A = 25^\circ\text{C}$ to 125°C | -2.5 | - | 2.5 | % |
| ETOT | Total Output Error | $I_P = 20\text{A}, T_A = 25^\circ\text{C}$ | -1.9 | - | 1.9 | % |
| | | $I_P = 20\text{A}, T_A = -40^\circ\text{C}$ to 25°C | -3.5 | - | 3.5 | % |
| | | $I_P = 20\text{A}, T_A = 25^\circ\text{C}$ to 125°C | -3.5 | - | 3.5 | % |

* Device may be operated at higher primary current levels, ambient temperatures, and internal leadframe temperatures, provided the Maximum Junction Temperature, is not exceeded.

MT9223CT-25BR5 At $T_A = -40 \sim 125^\circ\text{C}$, $V_{CC} = 5\text{V}$ (unless otherwise specified)

| Symbol | Parameters | Test Condition | Min | Typ | Max | Unit |
|--------|-------------------------------|---|------|---------------------|-----|------|
| IPR | Optimized Input Current Range | | -25 | - | 25 | A |
| SNST | Sensitivity | $-25\text{A} \leq I_P \leq 25\text{A}$ | - | 80 | - | mV/A |
| VOQ | Zero-Current Output Voltage | | - | $V_{CC} \times 0.5$ | - | V |
| VOE | Zero-Current Output Error | $I_P = 0\text{ A}, T_A = 25^\circ\text{C}$ | -10 | - | 10 | mV |
| | | $I_P = 0\text{ A}, T_A = -40^\circ\text{C}$ to 25°C | -25 | - | 25 | mV |
| | | $I_P = 0\text{ A}, T_A = 25^\circ\text{C}$ to 125°C | -25 | - | 25 | mV |
| ESNST | Sensitivity Error | $I_P = 25\text{A}, T_A = 25^\circ\text{C}$ | -1.5 | - | 1.5 | % |
| | | $I_P = 25\text{A}, T_A = -40^\circ\text{C}$ to 25°C | -2.5 | - | 2.5 | % |
| | | $I_P = 25\text{A}, T_A = 25^\circ\text{C}$ to 125°C | -2.5 | - | 2.5 | % |
| ETOT | Total Output Error | $I_P = 25\text{A}, T_A = 25^\circ\text{C}$ | -1.9 | - | 1.9 | % |
| | | $I_P = 25\text{A}, T_A = -40^\circ\text{C}$ to 25°C | -3.5 | - | 3.5 | % |
| | | $I_P = 25\text{A}, T_A = 25^\circ\text{C}$ to 125°C | -3.5 | - | 3.5 | % |

* Device may be operated at higher primary current levels, ambient temperatures, and internal leadframe temperatures, provided the Maximum Junction Temperature, is not exceeded.

MT9223CT-30UR5 At $T_A = -40 \sim 125^\circ\text{C}$, $V_{CC}=5\text{V}$ (unless otherwise specified)

| Symbol | Parameters | Test Condition | Min | Typ | Max | Unit |
|--------|-------------------------------|--|------|---------------------|-----|------|
| IPR | Optimized Input Current Range | | 0 | - | 30 | A |
| SNST | Sensitivity | $0\text{A} \leq I_P \leq 30\text{A}$ | - | 133.3 | - | mV/A |
| VOQ | Zero-Current Output Voltage | | - | $V_{CC} \times 0.1$ | - | V |
| VOE | Zero-Current Output Error | $I_P=0\text{ A}$, $T_A=25^\circ\text{C}$ | -10 | - | 10 | mV |
| | | $I_P=0\text{ A}$, $T_A=-40^\circ\text{C}$ to 25°C | -25 | - | 25 | mV |
| | | $I_P=0\text{ A}$, $T_A=25^\circ\text{C}$ to 125°C | -25 | - | 25 | mV |
| ESNST | Sensitivity Error | $I_P=30\text{A}$, $T_A=25^\circ\text{C}$ | -1.5 | - | 1.5 | % |
| | | $I_P=30\text{A}$, $T_A=-40^\circ\text{C}$ to 25°C | -2.5 | - | 2.5 | % |
| | | $I_P=30\text{A}$, $T_A=25^\circ\text{C}$ to 125°C | -2.5 | - | 2.5 | % |
| ETOT | Total Output Error | $I_P=30\text{A}$, $T_A=25^\circ\text{C}$ | -1.9 | - | 1.9 | % |
| | | $I_P=30\text{A}$, $T_A = -40^\circ\text{C}$ to 25°C | -3.5 | - | 3.5 | % |
| | | $I_P=30\text{A}$, $T_A = 25^\circ\text{C}$ to 125°C | -3.5 | - | 3.5 | % |

* Device may be operated at higher primary current levels, ambient temperatures, and internal leadframe temperatures, provided the Maximum Junction Temperature, is not exceeded.

MT9223CT-30BR5 At $T_A = -40 \sim 125^\circ\text{C}$, $V_{CC}=5\text{V}$ (unless otherwise specified)

| Symbol | Parameters | Test Condition | Min | Typ | Max | Unit |
|--------|-------------------------------|--|------|---------------------|-----|------|
| IPR | Optimized Input Current Range | | -30 | - | 30 | A |
| SNST | Sensitivity | $-30\text{A} \leq I_P \leq 30\text{A}$ | - | 66.6 | - | mV/A |
| VOQ | Zero-Current Output Voltage | | - | $V_{CC} \times 0.5$ | - | V |
| VOE | Zero-Current Output Error | $I_P=0\text{ A}$, $T_A=25^\circ\text{C}$ | -10 | - | 10 | mV |
| | | $I_P=0\text{ A}$, $T_A=-40^\circ\text{C}$ to 25°C | -25 | - | 25 | mV |
| | | $I_P=0\text{ A}$, $T_A=25^\circ\text{C}$ to 125°C | -25 | - | 25 | mV |
| ESNST | Sensitivity Error | $I_P=30\text{A}$, $T_A=25^\circ\text{C}$ | -1.5 | - | 1.5 | % |
| | | $I_P=30\text{A}$, $T_A=-40^\circ\text{C}$ to 25°C | -2.5 | - | 2.5 | % |
| | | $I_P=30\text{A}$, $T_A=25^\circ\text{C}$ to 125°C | -2.5 | - | 2.5 | % |
| ETOT | Total Output Error | $I_P=30\text{A}$, $T_A=25^\circ\text{C}$ | -1.9 | - | 1.9 | % |
| | | $I_P=30\text{A}$, $T_A = -40^\circ\text{C}$ to 25°C | -3.5 | - | 3.5 | % |
| | | $I_P=30\text{A}$, $T_A = 25^\circ\text{C}$ to 125°C | -3.5 | - | 3.5 | % |

* Device may be operated at higher primary current levels, ambient temperatures, and internal leadframe temperatures, provided the Maximum Junction Temperature, is not exceeded.

MT9223CT-35UR5 At $T_A = -40 \sim 125^\circ\text{C}$, $V_{CC} = 5\text{V}$ (unless otherwise specified)

| Symbol | Parameters | Test Condition | Min | Typ | Max | Unit |
|--------|-------------------------------|---|------|---------------------|-----|------|
| IPR | Optimized Input Current Range | | 0 | - | 35 | A |
| SNST | Sensitivity | $0\text{A} \leq I_P \leq 35\text{A}$ | - | 114.3 | - | mV/A |
| VOQ | Zero-Current Output Voltage | | - | $V_{CC} \times 0.1$ | - | V |
| VOE | Zero-Current Output Error | $I_P = 0\text{ A}, T_A = 25^\circ\text{C}$ | -10 | - | 10 | mV |
| | | $I_P = 0\text{ A}, T_A = -40^\circ\text{C}$ to 25°C | -25 | - | 25 | mV |
| | | $I_P = 0\text{ A}, T_A = 25^\circ\text{C}$ to 125°C | -25 | - | 25 | mV |
| ESNST | Sensitivity Error | $I_P = 35\text{A}, T_A = 25^\circ\text{C}$ | -1.5 | - | 1.5 | % |
| | | $I_P = 35\text{A}, T_A = -40^\circ\text{C}$ to 25°C | -2.5 | - | 2.5 | % |
| | | $I_P = 35\text{A}, T_A = 25^\circ\text{C}$ to 125°C | -3.0 | - | 3.0 | % |
| ETOT | Total Output Error | $I_P = 35, T_A = 25^\circ\text{C}$ | -1.9 | - | 1.9 | % |
| | | $I_P = 35\text{A}, T_A = -40^\circ\text{C}$ to 25°C | -3.5 | - | 3.5 | % |
| | | $I_P = 35\text{A}, T_A = 25^\circ\text{C}$ to 125°C | -4.0 | - | 4.0 | % |

* Device may be operated at higher primary current levels, ambient temperatures, and internal leadframe temperatures, provided the Maximum Junction Temperature, is not exceeded.

MT9223CT-40BR5 At $T_A = -40 \sim 125^\circ\text{C}$, $V_{CC} = 5\text{V}$ (unless otherwise specified)

| Symbol | Parameters | Test Condition | Min | Typ | Max | Unit |
|--------|-------------------------------|---|------|---------------------|-----|------|
| IPR | Optimized Input Current Range | | -40 | - | 40 | A |
| SNST | Sensitivity | $-40\text{A} \leq I_P \leq 40\text{A}$ | - | 50 | - | mV/A |
| VOQ | Zero-Current Output Voltage | | - | $V_{CC} \times 0.5$ | - | V |
| VOE | Zero-Current Output Error | $I_P = 0\text{ A}, T_A = 25^\circ\text{C}$ | -10 | - | 10 | mV |
| | | $I_P = 0\text{ A}, T_A = -40^\circ\text{C}$ to 25°C | -25 | - | 25 | mV |
| | | $I_P = 0\text{ A}, T_A = 25^\circ\text{C}$ to 125°C | -25 | - | 25 | mV |
| ESNST | Sensitivity Error | $I_P = 40\text{A}, T_A = 25^\circ\text{C}$ | -1.5 | - | 1.5 | % |
| | | $I_P = 40\text{A}, T_A = -40^\circ\text{C}$ to 25°C | -2.5 | - | 2.5 | % |
| | | $I_P = 40\text{A}, T_A = 25^\circ\text{C}$ to 125°C | -3.0 | - | 3.0 | % |
| ETOT | Total Output Error | $I_P = 40\text{A}, T_A = 25^\circ\text{C}$ | -1.9 | - | 1.9 | % |
| | | $I_P = 40\text{A}, T_A = -40^\circ\text{C}$ to 25°C | -3.5 | - | 3.5 | % |
| | | $I_P = 40\text{A}, T_A = 25^\circ\text{C}$ to 125°C | -4.0 | - | 4.0 | % |

* Device may be operated at higher primary current levels, ambient temperatures, and internal leadframe temperatures, provided the Maximum Junction Temperature, is not exceeded.

MT9223CT-50BR5 At $T_A = -40 \sim 125\text{ }^\circ\text{C}$, $V_{CC} = 5\text{V}$ (unless otherwise specified)

| Symbol | Parameters | Test Condition | Min | Typ | Max | Unit |
|--------|-------------------------------|--|------|---------------------|-----|------|
| IPR | Optimized Input Current Range | | -50 | - | 50 | A |
| SNST | Sensitivity | $-50\text{A} \leq I_P \leq 50\text{A}$ | - | 40 | - | mV/A |
| VOQ | Zero-Current Output Voltage | | - | $V_{CC} \times 0.5$ | - | V |
| VOE | Zero-Current Output Error | $I_P = 0\text{ A}$, $T_A = 25^\circ\text{C}$ | -10 | - | 10 | mV |
| | | $I_P = 0\text{ A}$, $T_A = -40^\circ\text{C}$ to 25°C | -25 | - | 25 | mV |
| | | $I_P = 0\text{ A}$, $T_A = 25^\circ\text{C}$ to 125°C | -25 | - | 25 | mV |
| ESNST | Sensitivity Error | $I_P = 50\text{A}$, $T_A = 25^\circ\text{C}$ | -1.5 | - | 1.5 | % |
| | | $I_P = 50\text{A}$, $T_A = -40^\circ\text{C}$ to 25°C | -2.5 | - | 2.5 | % |
| | | $I_P = 50\text{A}$, $T_A = 25^\circ\text{C}$ to 125°C | -3.5 | - | 3.5 | % |
| ETOT | Total Output Error | $I_P = 50\text{A}$, $T_A = 25^\circ\text{C}$ | -1.9 | - | 1.9 | % |
| | | $I_P = 50\text{A}$, $T_A = -40^\circ\text{C}$ to 25°C | -3.5 | - | 3.5 | % |
| | | $I_P = 50\text{A}$, $T_A = 25^\circ\text{C}$ to 125°C | -4.5 | - | 4.5 | % |

* Device may be operated at higher primary current levels, ambient temperatures, and internal leadframe temperatures, provided the Maximum Junction Temperature, is not exceeded.

12 Characteristic Definitions

Power On Time---TPO

When the supply is ramped to its operating voltage, the device requires a finite time to power its internal components before responding to an input magnetic field.

The Power-On Time (TPO) is defined as the time taken between the supply reaching the minimum operating voltage V_{CCmin} (t_1), and the output voltage to settling to within $\pm 10\%$ of its steady state value under an applied magnetic field (t_2) (See Figure 6).

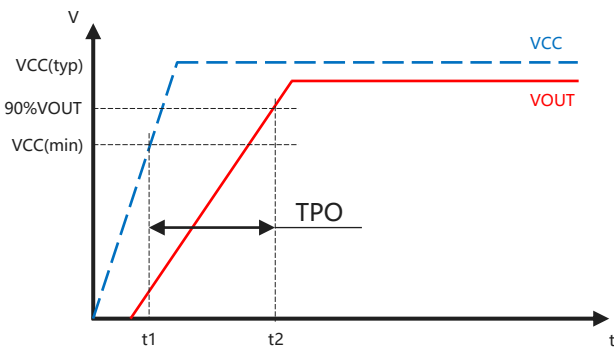


Figure.6 Power On Time Definition

Propagation Delay---TPD

The time interval between a) when the primary current signal reaches 20% of its final value, and b) when the output reaches 20% of its final value (see Figure 7).

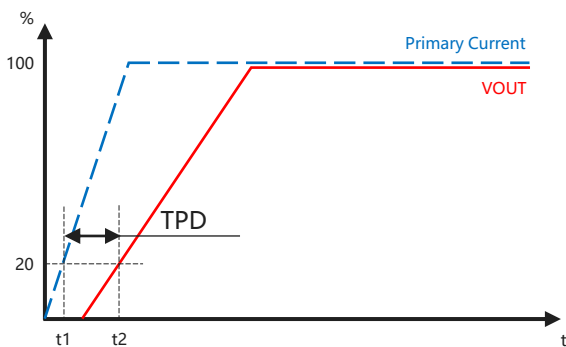


Figure.7 Propagation Delay Definition

Rise Time---TR

Rise Time is the time interval between the sensor V_{OUT} reaching 10% of its full scale value (t_1), and it reaching 90% of its full scale value (t_2). (see Figure 8). Both T_R and T_{RESP} can be negatively affected by any eddy current losses created if a conductive ground plane is used.

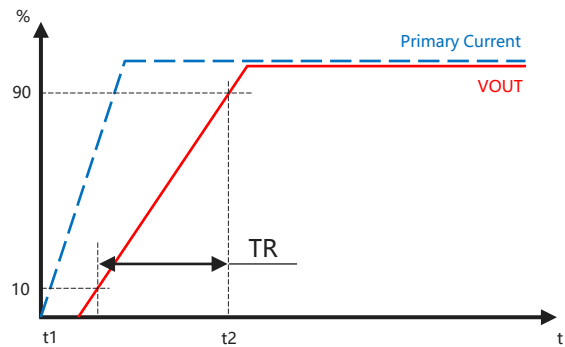


Figure.8 Rise Time Definition

Response Time---TRESP

The time interval between a) when the primary current signal reaches 80% of its final value, and b) when the sensor reaches 80% of its output corresponding to the applied current. (see Figure 9). Both T_R and T_{RESP} can be negatively affected by any eddy current losses created if a conductive ground plane is used.

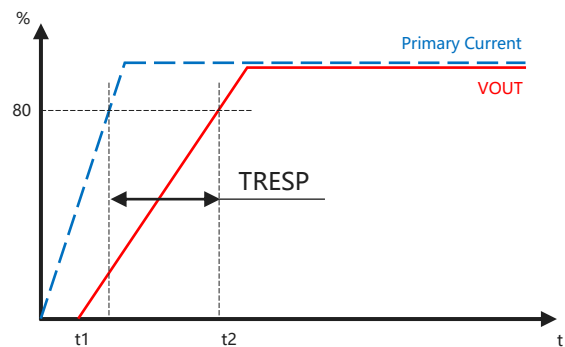


Figure.9 Response Time Definition

Zero-Current Output Voltage---VOQ

VOQ is the voltage output when the primary current is zero. For a unipolar supply voltage, it nominally remains at $0.5 \times VCC$ for a bidirectional device and $0.1 \times VCC$ for a unidirectional device. For example, in the case of a bidirectional output device, $VCC=5V$ translates into $VOQ=2.5V$. Variation in VOQ from the nominal value is due to thermal drift and the resolution limits of voltage offset trimming in the factory.

Zero-Current Output Error---VOE

The deviation of the device output from its ideal quiescent value of $0.5 \times VCC$ (bidirectional) or $0.1 \times VCC$ (unidirectional) due to nonmagnetic causes. To convert this voltage to amp, divide by the device sensitivity (SNST).

Sensitivity---SNST

The Sensitivity in mV/A indicates how much the output changes when the primary current changes. It is the product of the magnetic circuit sensitivity (G/A) ($1G = 0.1mT$) and the linear IC amplifier gain (mV/G). The linear IC amplifier gain is programmed at the factory to optimize the sensitivity (mV/A) for the full-scale current of the device.

$$SNST = \left(\frac{VOUT_IPOSx - VOUT_INEGx}{IPOSx - INEGx} \right)$$

where IPOSx and INEGx are two current values with opposite polarities.

Total Output Error---ETOT

The accuracy represents the maximum deviation of the actual current output from its ideal current value. This is equivalent to the difference between the actual output voltage and the ideal output voltage, divided by the ideal sensitivity, relative to the current flowing through the primary conduction path:

$$ETOT(IP) = \left(\frac{VOUT_IP - VOUT_ideal(IP)}{SNST_ideal * IP} \right) * 100\%$$

Nonlinearity Sensitivity Error---ELIN

Ideally the primary current vs sensor output function is a straight line. The non-linearity is an indication of the worst deviation from this straight line. The ELIN in % is defined as:

$$ELIN = \left(\frac{SNST_I1}{SNST_I2} - 1 \right) * 100\%$$

Where:

$$SNST_I1 = \left(\frac{VOUT_IPOS1 - VOUT_INEG1}{IPOS1 - INEG1} \right)$$

$$SNST_I2 = \left(\frac{VOUT_IPOS2 - VOUT_INEG2}{IPOS2 - INEG2} \right)$$

and IPOSx and INEGx are positive and negative current values, with respect to the quiescent voltage output such that $|IPOS2| = |INEG2| = IPRmax$, and $|IPOS2| = 2 \times |IPOS1|$ and $|INEG2| = 2 \times |INEG1|$.

Ratiometry Error---ERAT

The MT9223 device features ratiometric output. This means that the Quiescent Voltage Output (VOQ) and sensitivity (SNST), are proportional to the Supply Voltage, VCC. In other words, when the supply voltage increases or decreases by a certain percentage, each characteristic also increases or decreases by the same percentage. Error is the difference between the measured change in the supply voltage relative to 5 V, and the measured change in each characteristic.

Ratiometry Quiescent Voltage Output Error---ERAT_VOQ

ERAT_VOQ, for a given supply voltage, is defined as:

$$ERAT_VOQ = \left(\frac{VOQ(VCC)/VCC}{VOQ(5V)/5V} - 1 \right) * 100\%$$

Ratiometry Sensitivity Error---ERAT_SNST

ERAT_SNST, for a given supply voltage, is defined as:

$$ERAT_SNST = \left(\frac{SNST_I1(VCC)/VCC}{SNST_I1(5V)/5V} - 1 \right) * 100\%$$

Power-On Reset---POR

The descriptions in this section assume temperature = 25°C, no output load (RL, CL) , and no the applied current is present.

Power-Up. At power-up, as VCC ramps up, the output is in a high-impedance state. When VCC crosses VPORH, the output will go to VCC/2 after POR Release counter (TPORR) + POR Analog delay (TPORA).

VCC drops below VCC(min) = 4.5 V. If VCC drops below VPORL, the output will be in a high-impedance state. If VCC recovers and exceeds VPORH, the output will go back to normal operation after POR Release counter (TPORR) + POR Analog delay (TPORA) (See Figure. 10).

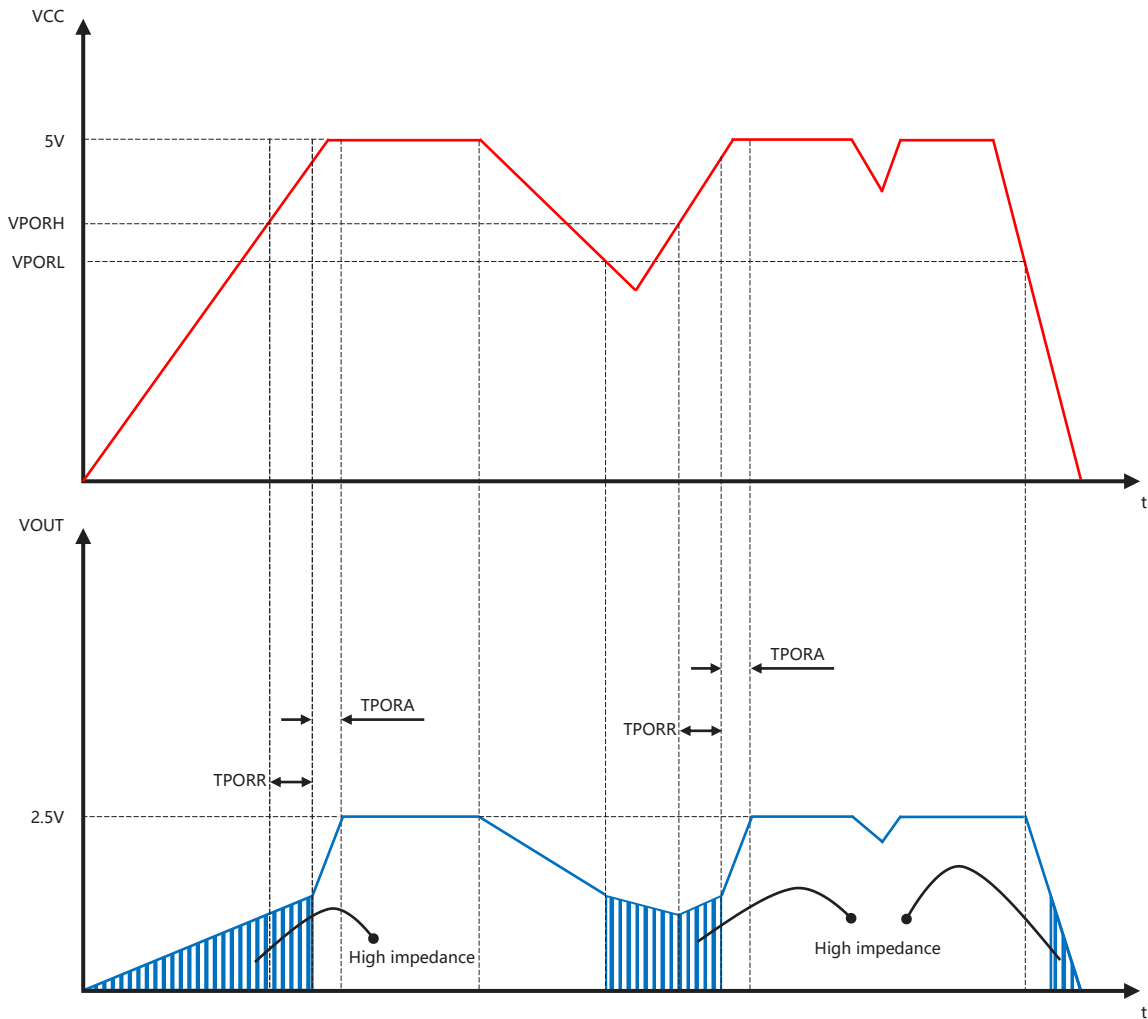
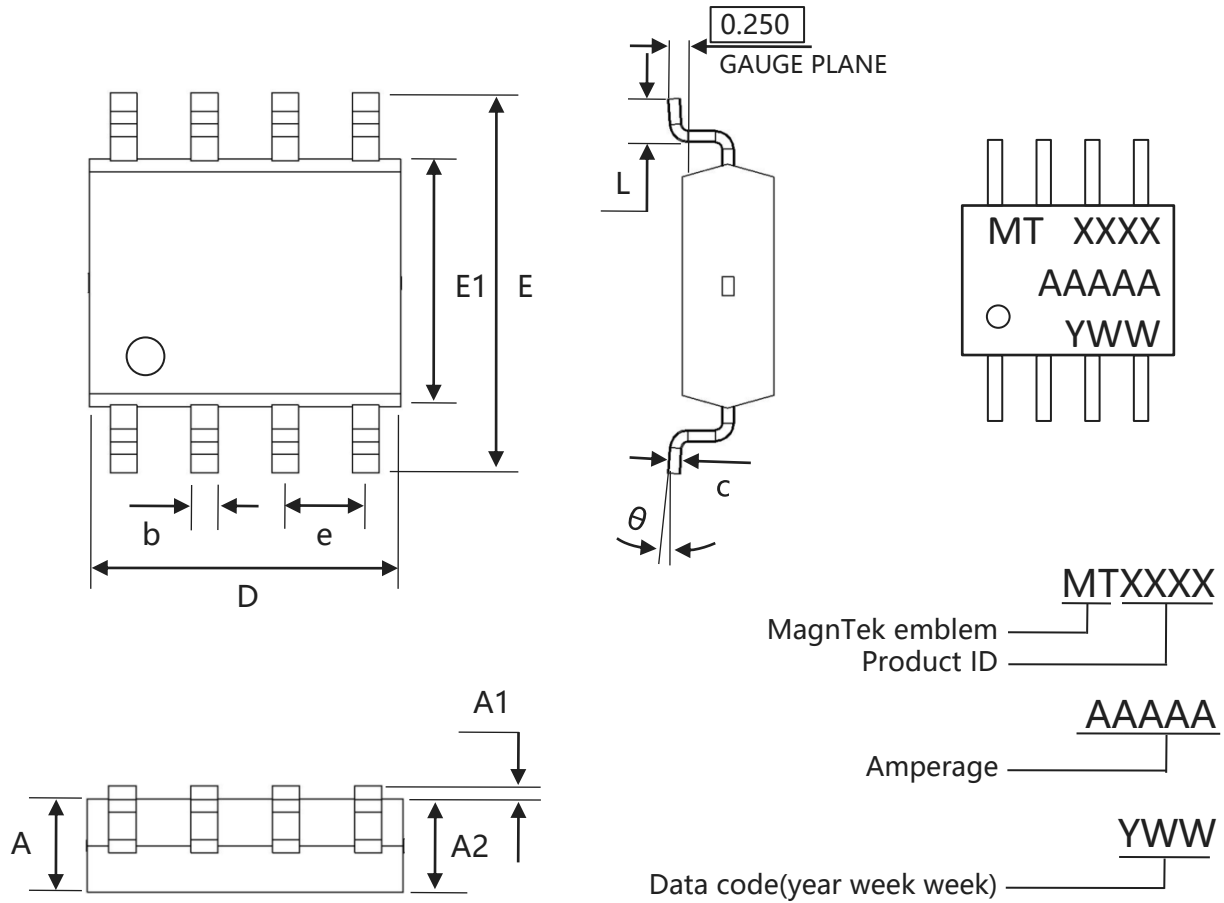


Figure.10 Power-On Reset Definition

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

13.1 SOP-8 Package Information



| Symbol | Dimensions in Millimeters | | Dimensions in Inches | |
|----------|---------------------------|-------|----------------------|-------|
| | Min | Max | Min | Max |
| A | 1.450 | 1.750 | 0.057 | 0.069 |
| A1 | 0.100 | 0.250 | 0.004 | 0.010 |
| A2 | 1.350 | 1.550 | 0.053 | 0.061 |
| b | 0.330 | 0.510 | 0.013 | 0.020 |
| c | 0.170 | 0.250 | 0.007 | 0.010 |
| D | 4.700 | 5.100 | 0.185 | 0.201 |
| E | 5.800 | 6.200 | 0.228 | 0.244 |
| E1 | 3.800 | 4.000 | 0.150 | 0.157 |
| e | 1.270(BSC) | | 0.050(BSC) | |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

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