MT9221

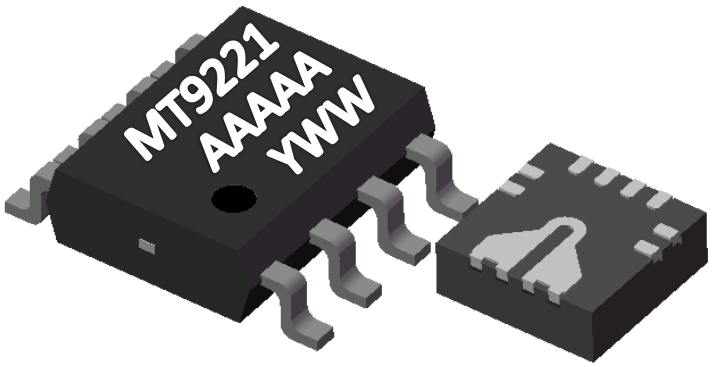
Fully Integrated, Hall Effect-Based Linear Current Sensor IC with 150kHz Bandwidth and 2.6 kVRMS Isolation

1 Product Description

The MagnTek® MT9221 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 MT9221 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 1.5 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 MT9221 current sensor IC to be used in high-side current sense applications without use other costly isolation techniques.

The MT9221 family provides a variety of packages to customers: SOP-8 and QFN-12 for surface mount. All packages are 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℃~125℃ Operating Temperature
- Primary Conductor Resistance
  ---1.5mΩ (SOP-8)
  ---0.8mΩ (QFN-12)
- Sensing Current Range: (AC or DC)
  ---±6A, ±10A, ±20A, ±25A, ±30A
  ---+12A, +20A, +30A
- 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:
  ---2.6kVrms Dielectric Surge Isolation (SOP-8)
  ---500Vrms Dielectric Surge Isolation (QFN-12)
- Package Option:
  ---SOP-8
  ---QFN-12
- 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 MT9221

Part No.	Description
MT9221CT	SOP-8, tape & reel (3000pcs/bag)
MT9221QT	QFN-12, tape & reel (1000pcs/bag)

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Reversion History

1	Originally Version	
2	1.1 Version	Update ±25A range
3	1.2 Version	Update package marking
4	1.3 Version	Update Output Voltage vs. Input Current curve

5 Functional Block Diagram

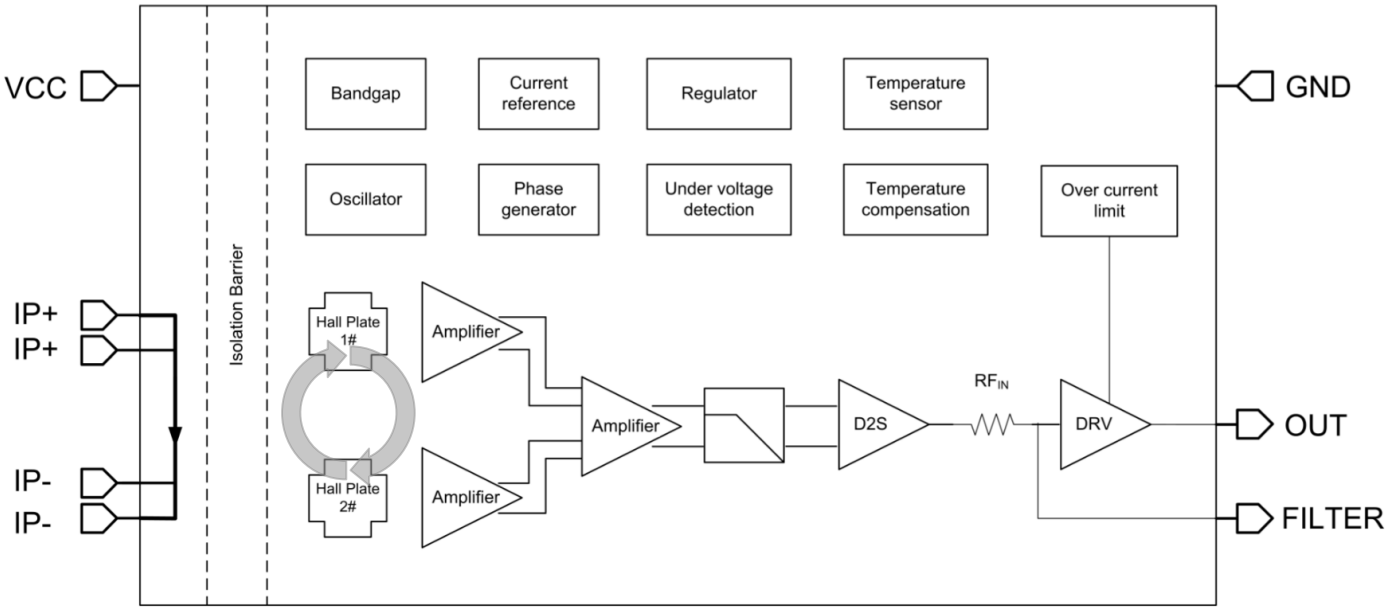


Figure.1 Functional Block Diagram

6 Naming Specification

Part Number MT9221 ❶ | CT ❷ | - | 10 ❸ | B ❹ | R ❺ | 5 ❻

❶ Series Name

❷ Package Type

Type	Package Type
CT	SOP-8
QT	QFN-12

❸ Input Current Range

Type	Input Current Range
06	Full scale sensing range: 6A
10	Full scale sensing range: 10A
12	Full scale sensing range: 12A
20	Full scale sensing range: 20A
25	Full scale sensing range: 25A
30	Full scale sensing range: 30A

❹ Current Polarity

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

❺ Output Mode

Type	Output Mode
R	Ratiometry output

❻ Power Supply

Type	Power Supply
5	VCC=5V

7 Output Voltage vs. Input Current

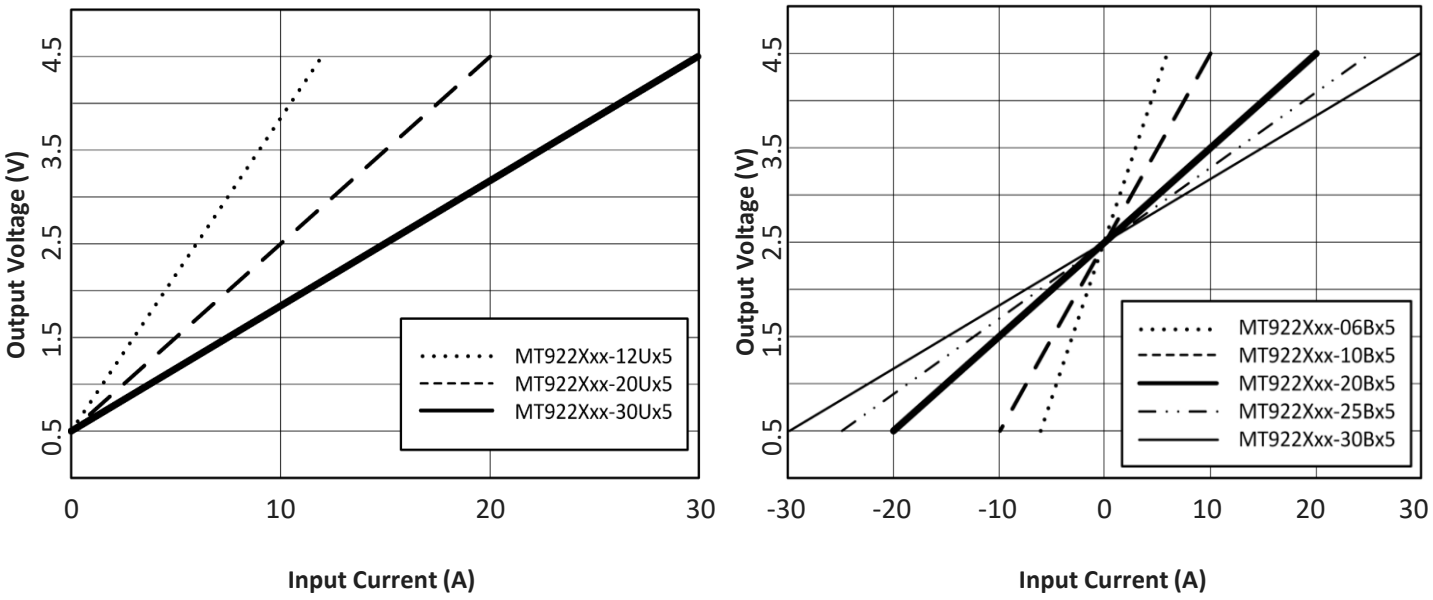


Figure.2 Output Voltage vs. Input Current

8 Typical Application Circuit

The typical application circuits of MT9221 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**.

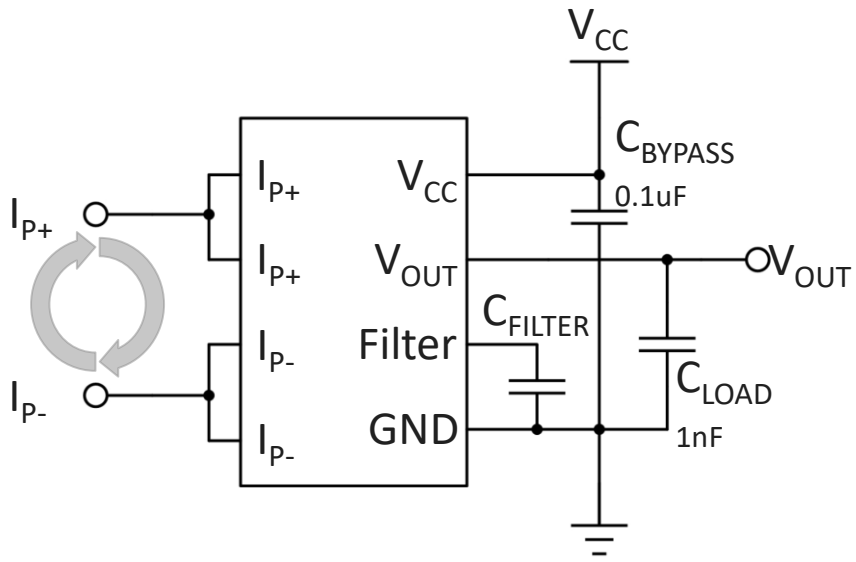
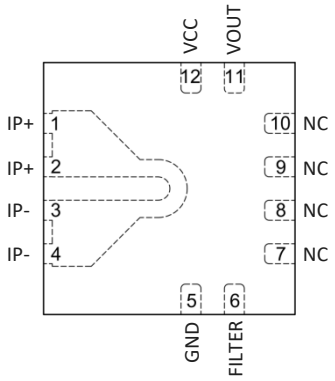


Figure.3 Typical Application Circuit

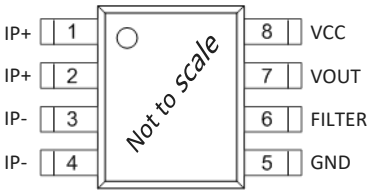
9 Pin Configuration and Functions



Top View

Figure.4 Pin Configuration & Functions (QFN-12)

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, 8, 9, 10	NC	No connection
11	VOUT	Analog Output Signal
12	VCC	Power Supply



Top View

Figure.5 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

10 Electrical Magnetic Characteristics

10.1 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	℃
TS	Storage Temperature	-50	150	℃
TJ	Junction Temperature	-	165	℃
MSL	SOP-8, QFN-12	1		Class

10.2 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)	SOP-8	2600	Vrms
			QFN-12	500	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

10.3 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

10.4 Electrical Specifications

At T_A =-40~125 ℃, V_{CC}=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	SOP-8	-	1.5	-	mΩ
		TA = 25°C	QFN-12	-	0.8	-	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, SOP-8		-	119	-	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...

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Electrical Specifications (*continued*)

At T_A =-40~125 ℃, V_{CC}=5V (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	TA = 25°C		±1	-	%
VPORH	Power-On Reset High Voltage	TA = 25°C, VCC rising	3.75	4	4.25	V
VPORL	Power-On Reset Low Voltage	TA = 25°C, VCC falling	-	3.5	-	V
VPORHYS	Power-On Reset Hysteresis	TA = 25°C	-	0.5	-	V
TPORR	Power-On Reset Release Time	TA = 25°C, VCC rising	-	30	-	us
TPORA	Power-On Reset Analog Delay	TA = 25°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	TA = 25°C, IOUT>ISCLP or IOUT<ISCLN	-	7	-	us
TSCLR	Release Time for Over-Current-Limit	TA = 25°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.

10.5 Accuracy Specifications

MT9221CT-06BR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		-6	-	6	A
SNST	Sensitivity	-6A≤IP≤6A	-	333	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.5	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-10	-	10	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=6A, TA=25°C	-1.5	-	1.5	%
		IP=6A, TA=-40°C to 25°C	-2.5	-	2.5	%
		IP=6A, TA=25°C to 125°C	-2.5	-	2.5	%
ETOT	Total Output Error	IP=6A, TA=25°C	-1.9	-	1.9	%
		IP=6A, TA = –40°C to 25°C	-3.5	-	3.5	%
		IP=6A, TA = 25°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.

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MT9221CT-12UR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		0	-	12	A
SNST	Sensitivity	0A≤IP≤12A	-	333	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.1	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-10	-	10	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=12A, TA=25°C	-1.5	-	1.5	%
		IP=12A, TA=-40°C to 25°C	-2.5	-	2.5	%
		IP=12A, TA=25°C to 125°C	-2.5	-	2.5	%
ETOT	Total Output Error	IP=12A, TA=25°C	-1.9	-	1.9	%
		IP=12A, TA = –40°C to 25°C	-3.5	-	3.5	%
		IP=12A, TA = 25°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.

MT9221CT-10BR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		-10	-	10	A
SNST	Sensitivity	-10A≤IP≤10A	-	200	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.5	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-10	-	10	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=10A, TA=25°C	-1.5	-	1.5	%
		IP=10A, TA=-40°C to 25°C	-2.5	-	2.5	%
		IP=10A, TA=25°C to 125°C	-2.5	-	2.5	%
ETOT	Total Output Error	IP=10A, TA=25°C	-1.9	-	1.9	%
		IP=10A, TA = –40°C to 25°C	-3.5	-	3.5	%
		IP=10A, TA = 25°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.

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MT9221CT-20UR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		0	-	20	A
SNST	Sensitivity	0A≤IP≤20A	-	200	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.1	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-10	-	10	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=20A, TA=25°C	-1.5	-	1.5	%
		IP=20A, TA=-40°C to 25°C	-2.5	-	2.5	%
		IP=20A, TA=25°C to 125°C	-2.5	-	2.5	%
ETOT	Total Output Error	IP=20A, TA=25°C	-1.9	-	1.9	%
		IP=20A, TA = –40°C to 25°C	-3.5	-	3.5	%
		IP=20A, TA = 25°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.

MT9221CT-20BR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		-20	-	20	A
SNST	Sensitivity	-20A≤IP≤20A	-	100	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.5	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-10	-	10	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=20A, TA=25°C	-1.5	-	1.5	%
		IP=20A, TA=-40°C to 25°C	-2.5	-	2.5	%
		IP=20A, TA=25°C to 125°C	-2.5	-	2.5	%
ETOT	Total Output Error	IP=20A, TA=25°C	-1.9	-	1.9	%
		IP=20A, TA = –40°C to 25°C	-3.5	-	3.5	%
		IP=20A, TA = 25°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.

MT9221CT-25BR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		-25	-	25	A
SNST	Sensitivity	-25A≤IP≤25A	-	80	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.5	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-10	-	10	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=25A, TA=25°C	-1.5	-	1.5	%
		IP=25A, TA=-40°C to 25°C	-2.5	-	2.5	%
		IP=25A, TA=25°C to 125°C	-2.5	-	2.5	%
ETOT	Total Output Error	IP=25A, TA=25°C	-1.9	-	1.9	%
		IP=25A, TA = –40°C to 25°C	-3.5	-	3.5	%
		IP=25A, TA = 25°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.

MT9221CT-30UR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		0	-	30	A
SNST	Sensitivity	0A≤IP≤30A	-	133.3	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.1	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-10	-	10	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=30A, TA=25°C	-1.5	-	1.5	%
		IP=30A, TA=-40°C to 25°C	-2.5	-	2.5	%
		IP=30A, TA=25°C to 125°C	-2.5	-	2.5	%
ETOT	Total Output Error	IP=30A, TA=25°C	-1.9	-	1.9	%
		IP=30A, TA = –40°C to 25°C	-3.5	-	3.5	%
		IP=30A, TA = 25°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.

MT9221CT-30BR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		-30	-	30	A
SNST	Sensitivity	-30A≤IP≤30A	-	66.7	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.5	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-10	-	10	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=30A, TA=25°C	-1.5	-	1.5	%
		IP=30A, TA=-40°C to 25°C	-2.5	-	2.5	%
		IP=30A, TA=25°C to 125°C	-2.5	-	2.5	%
ETOT	Total Output Error	IP=30A, TA=25°C	-1.9	-	1.9	%
		IP=30A, TA = –40°C to 25°C	-3.5	-	3.5	%
		IP=30A, TA = 25°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.

MT9221QT-06BR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		-6	-	6	A
SNST	Sensitivity	-6A≤IP≤6A	-	333	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.5	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-15	-	15	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=6A, TA=25°C	-1.5	-	1.5	%
		IP=6A, TA=-40°C to 25°C	-2.8	-	2.8	%
		IP=6A, TA=25°C to 125°C	-2.8	-	2.8	%
ETOT	Total Output Error	IP=6A, TA=25°C	-2.1	-	2.1	%
		IP=6A, TA = –40°C to 25°C	-3.8	-	3.8	%
		IP=6A, TA = 25°C to 125°C	-3.8	-	3.8	%

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

MT9221QT-12UR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		0	-	12	A
SNST	Sensitivity	0A≤IP≤12A	-	333	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.1	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-15	-	15	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=12A, TA=25°C	-1.5	-	1.5	%
		IP=12A, TA=-40°C to 25°C	-2.8	-	2.8	%
		IP=12A, TA=25°C to 125°C	-2.8	-	2.8	%
ETOT	Total Output Error	IP=12A, TA=25°C	-2.1	-	2.1	%
		IP=12A, TA = –40°C to 25°C	-3.8	-	3.8	%
		IP=12A, TA = 25°C to 125°C	-3.8	-	3.8	%

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

MT9221QT-10BR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		-10	-	10	A
SNST	Sensitivity	-10A≤IP≤10A	-	200	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.5	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-15	-	15	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=10A, TA=25°C	-1.5	-	1.5	%
		IP=10A, TA=-40°C to 25°C	-2.8	-	2.8	%
		IP=10A, TA=25°C to 125°C	-2.8	-	2.8	%
ETOT	Total Output Error	IP=10A, TA=25°C	-2.1	-	2.1	%
		IP=10A, TA = –40°C to 25°C	-3.8	-	3.8	%
		IP=10A, TA = 25°C to 125°C	-3.8	-	3.8	%

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

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MT9221QT-20UR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		0	-	20	A
SNST	Sensitivity	0A≤IP≤20A	-	200	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.1	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-15	-	15	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=20A, TA=25°C	-1.5	-	1.5	%
		IP=20A, TA=-40°C to 25°C	-2.8	-	2.8	%
		IP=20A, TA=25°C to 125°C	-2.8	-	2.8	%
ETOT	Total Output Error	IP=20A, TA=25°C	-2.1	-	2.1	%
		IP=20A, TA = –40°C to 25°C	-3.8	-	3.8	%
		IP=20A, TA = 25°C to 125°C	-3.8	-	3.8	%

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

MT9221QT-20BR5 At T_A=-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		-20	-	20	A
SNST	Sensitivity	-20A≤IP≤20A	-	100	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.5	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-15	-	15	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=20A, TA=25°C	-1.5	-	1.5	%
		IP=20A, TA=-40°C to 25°C	-2.8	-	2.8	%
		IP=20A, TA=25°C to 125°C	-2.8	-	2.8	%
ETOT	Total Output Error	IP=20A, TA=25°C	-2.1	-	2.1	%
		IP=20A, TA = –40°C to 25°C	-3.8	-	3.8	%
		IP=20A, TA = 25°C to 125°C	-3.8	-	3.8	%

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

MT9221QT-25BR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		-25	-	25	A
SNST	Sensitivity	-25A≤IP≤25A	-	80	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.5	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-15	-	15	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=25A, TA=25°C	-1.5	-	1.5	%
		IP=25A, TA=-40°C to 25°C	-2.8	-	2.8	%
		IP=25A, TA=25°C to 125°C	-2.8	-	2.8	%
ETOT	Total Output Error	IP=25A, TA=25°C	-2.1	-	2.1	%
		IP=25A, TA = –40°C to 25°C	-3.8	-	3.8	%
		IP=25A, TA = 25°C to 125°C	-3.8	-	3.8	%

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

MT9221QT-30UR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		0	-	30	A
SNST	Sensitivity	0A≤IP≤30A	-	133.3	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.1	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-15	-	15	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=30A, TA=25°C	-1.5	-	1.5	%
		IP=30A, TA=-40°C to 25°C	-2.8	-	2.8	%
		IP=30A, TA=25°C to 125°C	-3.0	-	3.0	%
ETOT	Total Output Error	IP=30A, TA=25°C	-2.1	-	2.1	%
		IP=30A, TA = –40°C to 25°C	-3.8	-	3.8	%
		IP=30A, TA = 25°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.

MT9221QT-30BR5 At T_A =-40~125 ℃, V_{CC}=5V (unless otherwise specified)

Symbol	Parameters	Test Condition	Min	Typ	Max	Unit
IPR	Optimized Input Current Range		-30	-	30	A
SNST	Sensitivity	-30A≤IP≤30A	-	66.7	-	mV/A
VOQ	Zero-Current Output Voltage		-	V_{CC}×0.5	-	V
VOE	Zero-Current Output Error	IP=0 A, TA=25°C	-15	-	15	mV
		IP=0 A, TA=-40°C to 25°C	-25	-	25	mV
		IP=0 A, TA=25°C to 125°C	-25	-	25	mV
ESNST	Sensitivity Error	IP=30A, TA=25°C	-1.5	-	1.5	%
		IP=30A, TA=-40°C to 25°C	-2.8	-	2.8	%
		IP=30A, TA=25°C to 125°C	-3.0	-	3.0	%
ETOT	Total Output Error	IP=30A, TA=25°C	-2.1	-	2.1	%
		IP=30A, TA = –40°C to 25°C	-3.8	-	3.8	%
		IP=30A, TA = 25°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.

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11 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 VCCmin (t1), and the output voltage to settling to within ±10% of its steady state value under an applied magnetic field (t2) (See Figure 6).

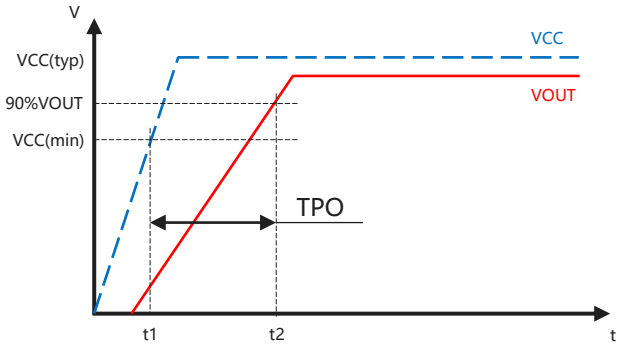


Figure.6 **Power On Time Definition**

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).

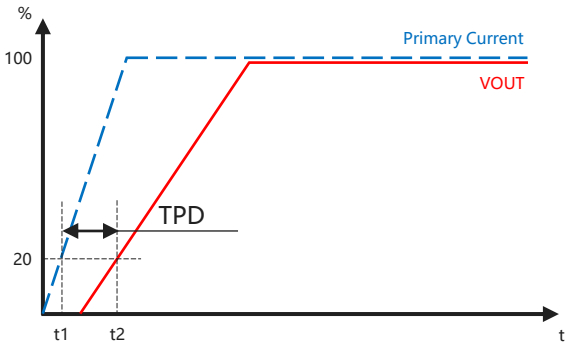


Figure.7 **Propagation Delay Definition**

Rise Time---TR

Rise Time is the time interval between the sensor VOUT reaching 10% of its full scale value (t1), and it reaching 90% of its full scale value (t2). (see Figure 8). Both TR and TRESP can be negatively affected by any eddy current losses created if a conductive ground plane is used.

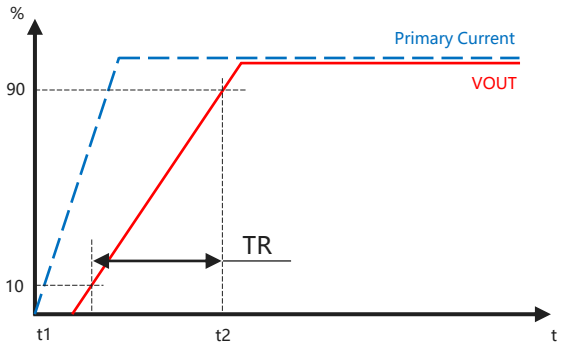


Figure.8 **Rise Time Definition**

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 TR and TRESP can be negatively affected by any eddy current losses created if a conductive ground plane is used.

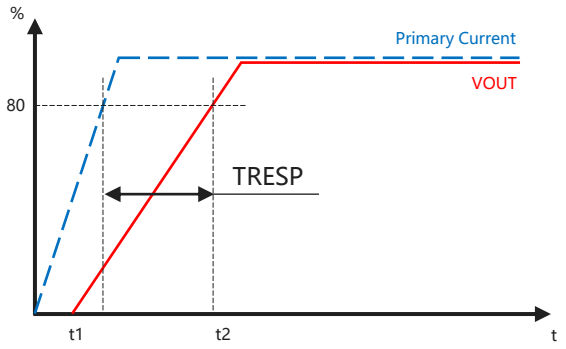


Figure.9 **Response Time Definition**

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 × VCC for a bidirectional device and 0.1 × 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 × VCC (bidirectional) or 0.1 × 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 × |IPOS1| and |INEG2| = 2 × |INEG1|.

Ratiometry Error---ERAT

The MT9221 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).

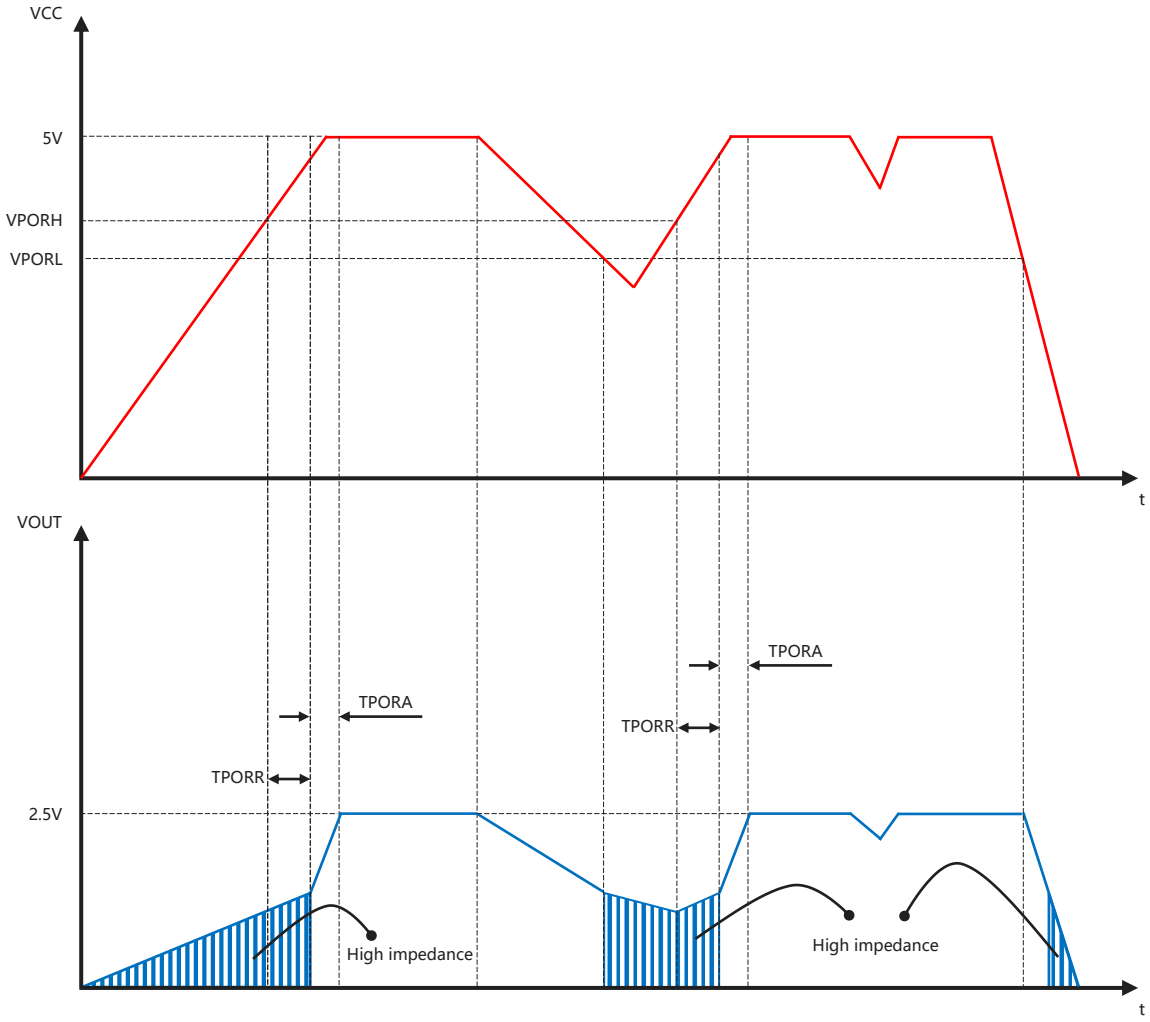
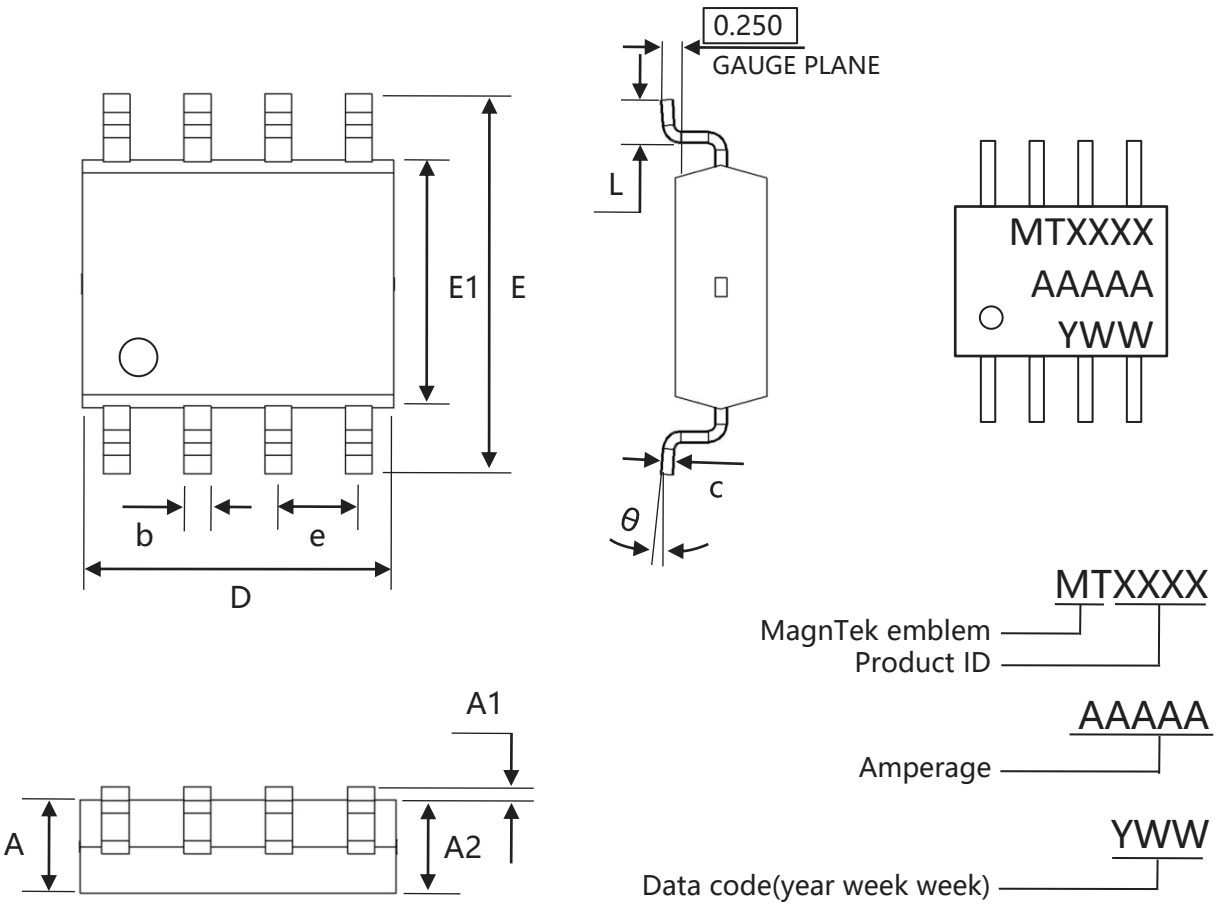


Figure.10 **Power-On Reset Definition**

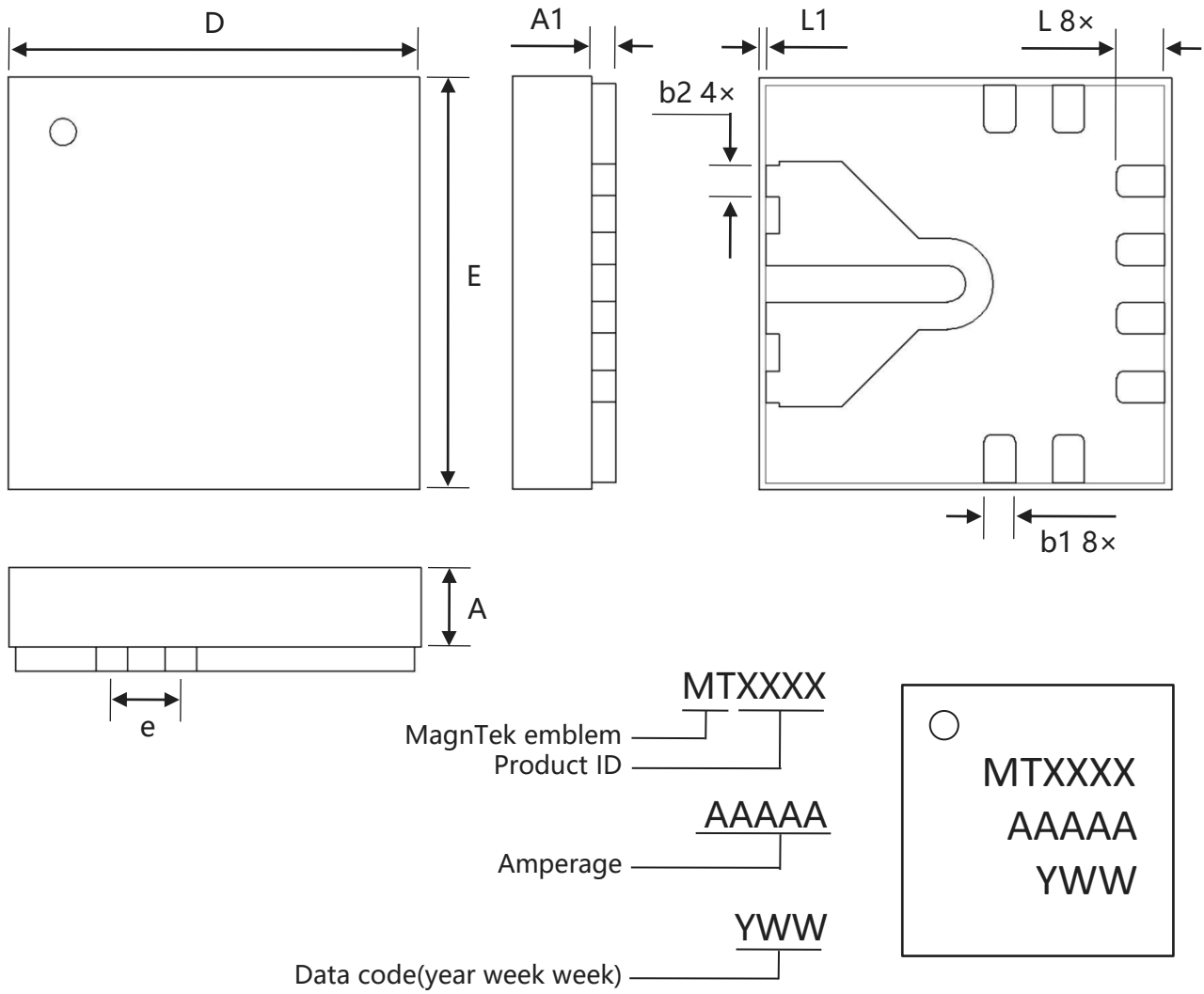
12 Package Material Information (For Reference Only – Not for Tooling Use)

12.1 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°

12.2 QFN-12 Package Information



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.175	0.300	0.007	0.012
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
b1	0.180	0.280	0.007	0.011
b2	0.180	0.280	0.007	0.011
L	0.300	0.400	0.012	0.016
L1	0.010	0.090	0.000	0.004
e	0.500 (BSC)		0.020 (BSC)	

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