# Low Noise, Low Power Dissipation, 16/24-Bit Σ-Δ ADC

PRODUCT DESCRIPTION

The MS5198T/MS5199T is a 16-bit/24-bit ADC featured by low power dissipation, low noise, three differential input channels and it is suitable for high-precision measurement application. The MS5198T/MS5199T integrates input buffer and instrumentation amplifier. When the gain is set to 64 and the update rate is 4.17Hz, the root mean square noise is 10nV. The output data rate can be set from 4.17Hz to 470Hz. The power supply voltage ranges from 2.7V to 5.25V. The MS5198T/MS5199T is available in TSSOP16 package.
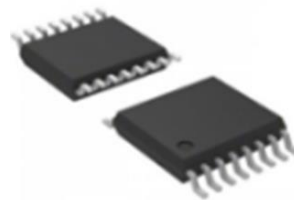
TSSOP16

FEATURES

● RMS Noise: MS5199T: 27nV@4.17Hz;65nV@16.7Hz

MS5198T: 40nV@4.17Hz;85nV@16.7Hz

● Power Dissipation: 380μA(typ)

● Integrated Low Noise, Programmable Gain Instrumentation Amplifier

● Update Rate: 4.17Hz to 470Hz

● Integrated Three Differential Input Channels and Internal Oscillator

● Integrated 50Hz/60Hz Rejection Filter

● Integrated Power Supply Detect

● Power Supply Voltage: 2.7V to 5.25V

● Operating Temperature Range: -40°C to 105°C

APPLICATIONS

● Thermocouple and RTD Measurement

● Stress Detection

● Gas Analysis and Blood Analysis

● Industrial Process Control and Instrumentation

● Liquid and Gas Chromatograph

● Smart Transmitter

● 6-bit DVM

PRODUCT SPECIFICATION

Part Number	Package	Marking
MS5198T	TSSOP16	MS5198T
MS5199T	TSSOP16	MS5199T

PIN CONFIGURATION
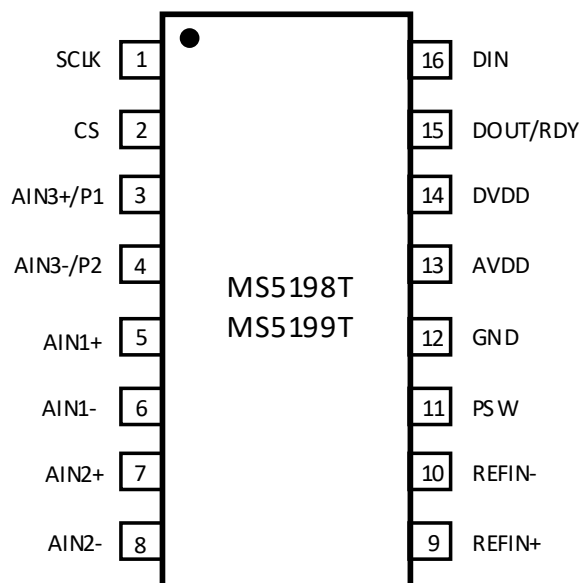
PIN DESCRIPTION

Pin	Name	Type	Description
1	SCLK	I	Serial Clock Input
2	CS	I	Chip Select Input
3	AIN3+/P1	I/O	Analog Channel 3 Positive Input/Digital Output Pin
4	AIN3-/P2	I/O	Analog Channel 3 Negative Input/Digital Output Pin
5	AIN1+	I	Analog Channel 1 Positive Input
6	AIN1-	I	Analog Channel 1 Negative Input
7	AIN2+	I	Analog Channel 2 Positive Input
8	AIN2-	I	Analog Channel 2 Negative Input
9	REFIN+	I	Positive Reference Voltage Input Pin
10	REFIN-	I	Negative Reference Voltage Input Pin
11	PSW	I	Low-Side Power Switch to GND
12	GND	-	Ground
13	AVDD	-	Analog Power Supply Voltage (2.7V to 5.25V)
14	DVDD	-	Digital Interface Power Pin
15	DOUT/RDY	O	Serial Data Output/Data Ready Output Pin
16	DIN	I	Serial Data Input

BLOCK DIAGRAM

GND　　　　AVDD　　　　　　　REFIN+　　REFIN-　　　　　DVDD

Input Mux

Amplifier

Buffer

∑−Δ ADC

SPI and Control

OSC

AIN1+
AIN1-
AIN2+
AIN2-
AIN3+/P1
AIN3-/P2

PSW

MS5199T: 24bit
MS5198T: 16bit

DOUT/RDY
DIN
SCLK
CS
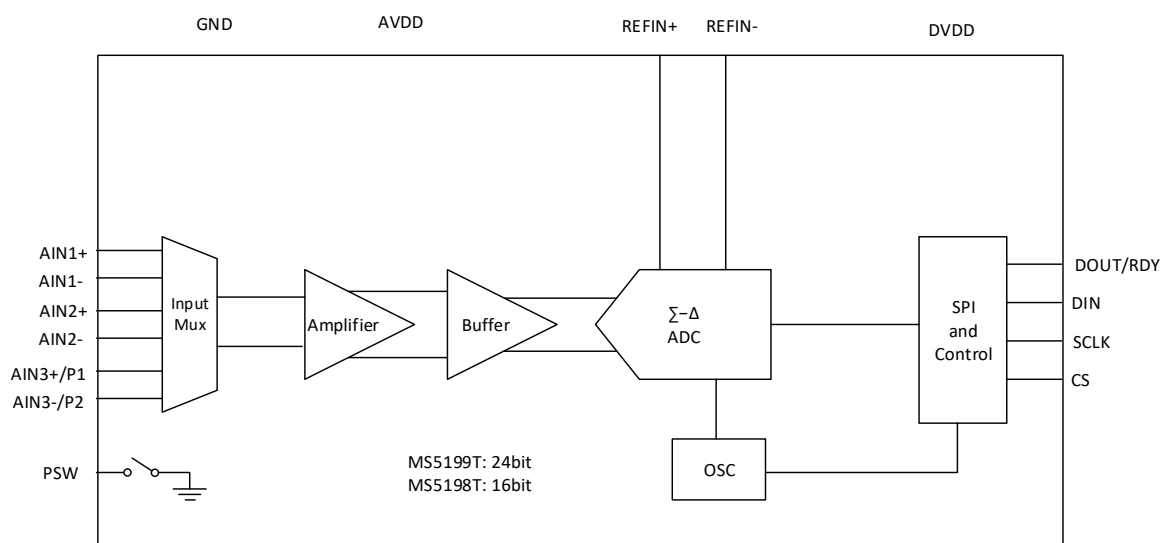
ABSOLUTE MAXIMUM RATINGS

Any exceeding absolute maximum rating application causes permanent damage to device. Because long-time absolute operation state affects device reliability. Absolute ratings just conclude from a series of extreme tests. It doesn't represent chip can operate normally in these extreme conditions.

Parameter	Symbol	Range	Unit
Analog Power Supply	AVDD	-0.3 ~ +7.0	V
Digital Power Supply	DVDD	-0.3 ~ +7.0	V
Analog Input Voltage	AIN	-0.3 ~ AVDD+0.3	V
Reference Voltage	VREFIN	-0.3 ~ AVDD+0.3	V
Digital Input Voltage		-0.3 ~ DVDD+0.3	V
Digital Output Voltage	V(LE)	-0.3 ~ DVDD+0.3	V
Input Port Current		10	mA
Operating Temperature		-40 ~ 105	°C
Storage Temperature	Tstg	-65 ~ 150	°C
Lead Temperature (10 sec)		260	°C
ESD(HBM)		4000	V

.

ELECTRICAL CHARACTERISTICS

AVDD=2.7V to 5.25V; DVDD=2.7V to 5.25V; GND=0V; REFIN(+)=AVDD; REFIN(-)=0V.

Unless otherwise noted, parameters are in whole temperature range.

Parameter	Condition	Min	Typ	Max	Unit
ADC Channel					
Output Rate			4.17-470		Hz
No Missing Codes Accuracy			24/16		Bits
Resolution	See "Output Noise and Resolution"				
Output Noise and Rate	See "Output Noise and Resolution"				
Integral Nonlinearity				±15	ppm of FSR
Offset Error			±1		µV
Offset Error Temperature Drift			±10		nV/°C
Full-Scale Error			±10		µV
Gain Temperature Drift			1		ppm/°C
Power Supply Rejection	AIN=1V/gain, Gain>4	80			dB
Analog Input					
Differential Input Voltage Range			±VREF/gain		V
Common-Mode Voltage	VCM= (AINP + AINN)/2, Gain = 4 to 128	0.5			V
Analog Input Voltage	Disable Input Buffer, Gain=1 or 2	GND-30mV		AVDD+30mV	V
	Enable Input Buffer, Gain=1 or 2	GND+100mV		AVDD -100mV	V
	Enable Input Instrumentation Amplifier, Gain=4 to 128	GND+300mV		AVDD-1.1	V
Analog Input Current When Buffered Mode or Enable Internal Instrumentation Amplifier	Gain = 1 or 2, Update Rate < 100 Hz			±1	nA
	Gain = 4 to 128, Update Rate < 100 Hz			±250	pA
	AIN3(+)/AIN3(−), Update Rate < 100 Hz			±1	nA

Parameter	Condition	Min	Typ	Max	Unit
Analog Input Current Temperature Drift When Buffered Mode or Enable Internal Instrumentation Amplifier			±2		pA/°C
Analog Input Current Relative to Voltage When Disable Input Buffer			±400		nA/V
Analog Input Current Temperature Drift When Disable Input Buffer			±50		pA/V/°C
Common-Mode Rejection	DC, AIN = 1 V/gain,Gain ≥ 4	100			dB
	50±1 Hz, 60 ± 1 Hz (FS[3:0] = 1010)	100			dB
	50±1 Hz (FS[3:0] = 1001), 60±1 Hz (FS[3:0] = 1000)	100			dB
External Reference					
Reference Voltage		0.1	2.5	AVDD	V
Average Current, Reference Voltage Input			400		nA/V
Average Current Temperature Drift, Reference Voltage Input			±0.03		nA/V/°C
Common-Mode Rejection			100		dB
Low-Side Power Switch					
On-resistance	AVDD=5V			7	Ω
	AVDD=3V			9	Ω
Allowable Current	Continual Current		30		mA
Digital Output (P1,P2)					
Output High-level Voltage	AVDD=3 V, ISOURCE=100µA	AVDD-0.6			V
	AVDD=5 V, ISOURCE=200µA	4			V
Output Low-level Voltage	AVDD=3 V, ISINK=100µA			0.4	V
	AVDD=5 V, ISINK=800µA			0.4	V
Internal Clock					
Frequency			64±3%		kHz
Logic Input					
CS Input Low Voltage	DVDD=5V			0.8	V
	DVDD=3V			0.4	V

Parameter	Condition	Min	Typ	Max	Unit
CS Input High Voltage		2.0			V
SCLK and DIN	DVDD=5V	1.4		2	V
Input High-level Threshold	DVDD=3V	0.9		2	V
SCLK and DIN	DVDD=5V	0.8		1.7	V
Input Low-level Threshold	DVDD=3V	0.4		1.35	V
SCLK and DIN Input Hysteresis	DVDD=5V	0.1		0.17	V
	DVDD=3V	0.06		0.13	V
Input Current				±10	µA
Input Capacitance			10		pF
Digital Logic Output					
Output High-level Voltage	DVDD=3 V, ISOURCE=100µA	DVDD-0.6			V
	DVDD=5 V, ISOURCE=200µA	4			V
Output Low-level Voltage	DVDD=3 V, ISINK=100µA			0.4	V
	DVDD=5 V, ISINK=1.6mA			0.4	V
Leakage Current, Floating-State				±10	µA
Output Capacitance, Floating-State			10		pF
System Calibration					
Full-Scale Calibration				1.05×FS	V
Zero-Scale Calibration		-1.05×FS		1.05×FS	V
Power Dissipation					
Power Supply Voltage	AVDD	2.7		5.25	V
	DVDD	2.7		5.25	V
Power Supply Current	AVDD=3V	Disable Input Buffer		110	140	µA
	AVDD=5V			125	140	
	AVDD=3V	Enable Input Buffer,		130	180	µA
	AVDD=5V	Gain=1 or 2		165	180	µA
	AVDD=3V	MS5198T, Gain=4 to 128		300	400	µA
	AVDD=5V			350	400	µA
	AVDD=3V	MS5199T, Gain=4 to 128		380	500	µA
	AVDD=5V			440	500	µA
Shut-down Current				1	µA

OUTPUT NOISE and RESOLUTION (EXTERNAL REFERENCE)

The table below gives the output RMS noise for MS5199T with some update rates and gain settings. These data are for bipolar input range and 2.5V external reference voltage source. These values are typical when the differential input voltage is 0V. It is important to note that the effective resolution is calculated from root mean square noise.

Table 1. Output RMS Noise (μV) VS.Gain and Update Rate for the MS5199T (2.5V Reference Voltage)

Update Rate	Gain=1	Gain=2	Gain=4	Gain=8	Gain=16	Gain=32	Gain=64	Gain=128
4.17Hz	0.451	0.316	0.135	0.073	0.037	0.023	0.008	0.010
8.33Hz	0.676	0.473	0.259	0.090	0.068	0.032	0.017	0.019
16.7Hz	1.217	0.699	0.406	0.214	0.085	0.051	0.021	0.019
33.2Hz	1.893	1.420	0.834	0.372	0.256	0.094	0.058	0.042
62Hz	1.938	1.555	0.856	0.417	0.194	0.096	0.057	0.052
123Hz	3.246	2.998	1.138	0.659	0.287	0.144	0.068	0.075
242Hz	8.880	5.657	1.893	1.195	0.696	0.424	0.168	0.140
470Hz	5.229	4.711	2.558	1.037	0.552	0.317	0.156	0.175

Table 2. Effective Resolution (Bits) VS. Gain and Update Rate for the MS5199T (2.5V Reference Voltage)

Update Rate	Gain=1	Gain=2	Gain=4	Gain=8	Gain=16	Gain=32	Gain=64	Gain=128
4.17Hz	23.1	22.6	22.8	22.7	22.7	22.4	22.8	21.6
8.33Hz	22.5	22.0	21.9	22.4	21.8	21.9	21.8	20.7
16.7Hz	21.7	21.5	21.3	21.2	21.5	21.3	21.5	20.7
33.2Hz	21.0	20.5	20.2	20.4	19.9	20.4	20.1	19.5
62Hz	21.0	20.3	20.2	20.2	20.3	20.3	20.1	19.2
123Hz	20.3	19.4	19.8	19.6	19.8	19.8	19.8	18.7
242Hz	18.8	18.5	19.0	18.7	18.5	18.2	18.5	17.8
470Hz	19.6	18.7	18.6	18.9	18.8	18.6	18.6	17.5

The table below gives the output RMS noise for MS5198T with some update rates and gain settings. The data provided are for bipolar input range and 2.5V external reference voltage source. These values are typical when the differential input voltage is 0V. It is important to note that the effective resolution is calculated from root mean square noise.
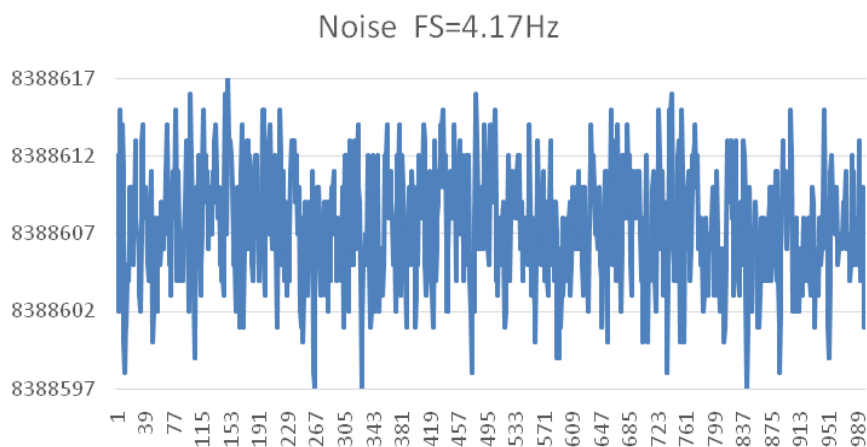
Table 3. Output RMS Noise (μV) VS. Gain and Update Rate for the MS5198T

| Update Rate	Gain=1	Gain=2	Gain=4	Gain=8	Gain=16	Gain=32	Gain=64	Gain=128
4.17Hz	0.496	0.361	0.180	0.079	0.042	0.021	0.011	0.013
8.33Hz	0.676	0.473	0.237	0.135	0.073	0.030	0.018	0.012
16.7Hz	1.082	0.947	0.349	0.225	0.099	0.046	0.025	0.016
33.2Hz	1.668	1.172	0.518	0.304	0.144	0.072	0.042	0.026
62Hz	2.164	1.916	0.687	0.423	0.194	0.108	0.050	0.059
123Hz	3.065	2.840	1.183	0.642	0.344	0.182	0.101	0.061
242Hz	6.626	7.708	2.783	1.268	0.716	0.347	0.164	0.206
470Hz	5.860	6.897	2.660	1.211	0.569	0.256	0.132	0.165

Table 4. Typical Resolution (Bits) vs. Gain and Update Rate for the MS5198T

| Update Rate	Gain=1	Gain=2	Gain=4	Gain=8	Gain=16	Gain=32	Gain=64	Gain=128
4.17Hz	16	16	16	16	16	16	16	16
8.33Hz	16	16	16	16	16	16	16	16
16.7Hz	16	16	16	16	16	16	16	16
33.2Hz	16	16	16	16	16	16	16	16
62Hz	16	16	16	16	16	16	16	16
123Hz	16	16	16	16	16	16	16	16
242Hz	16	16	16	16	16	16	16	16
470Hz	16	16	16	16	16	16	16	16

TYPICAL CHARACTERISTICS CURVES

Noise FS=4.17Hz

MS5199TNoise (AVDD=4V, VREF=2.048, Gain= 64, Update Rate = 4.17Hz)

Noise Distribution Histogram FS=4.17Hz
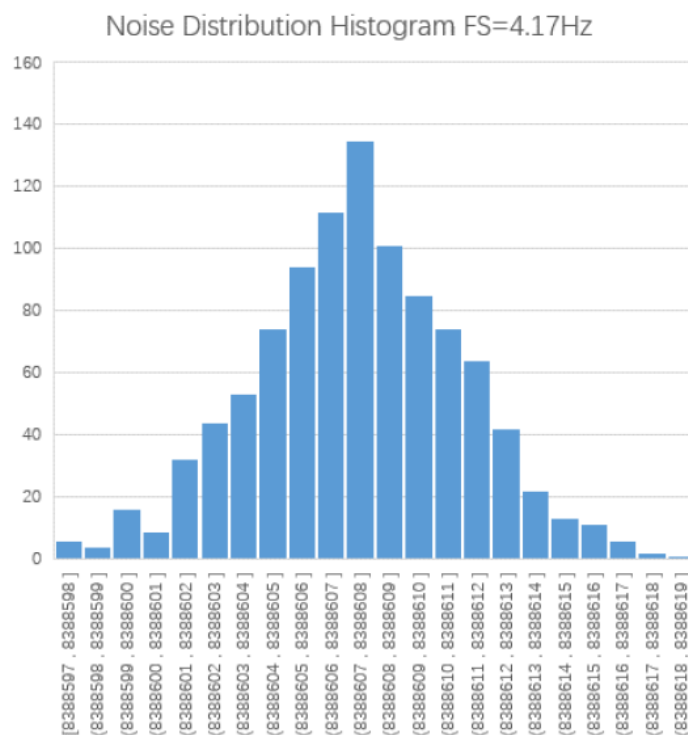
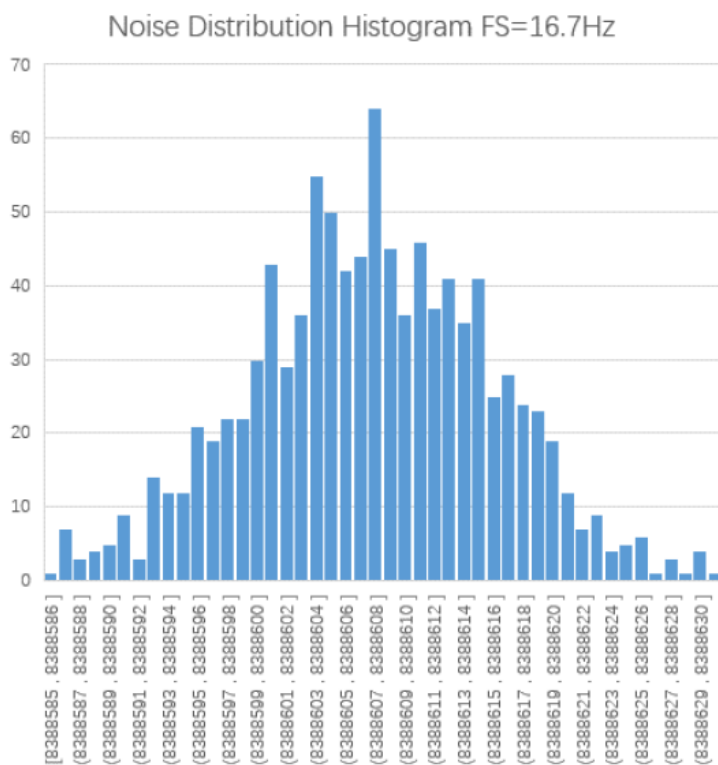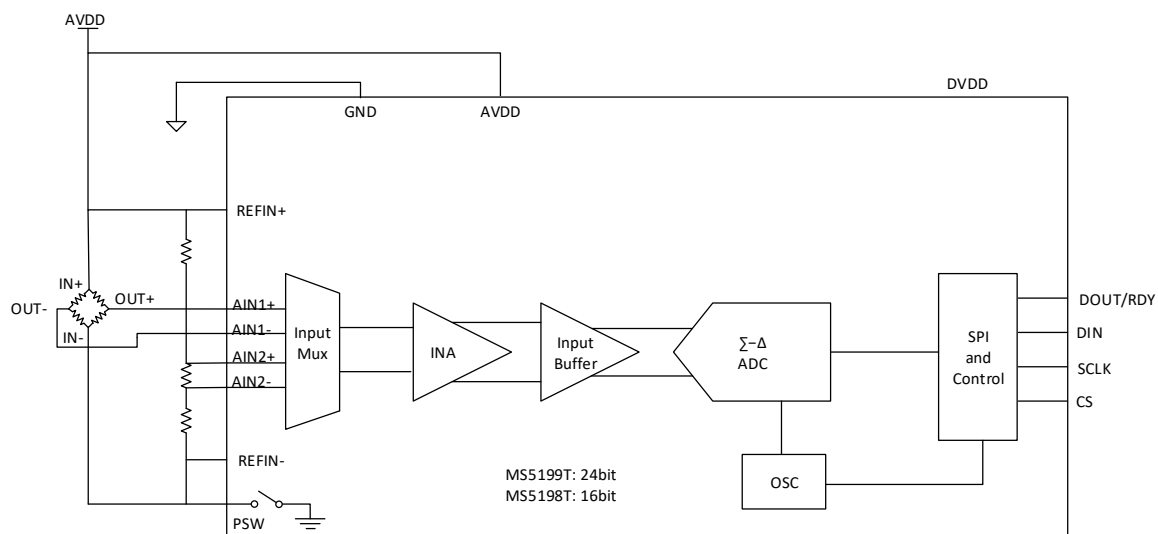MS5199T Noise Distribution Histogram (AVDD=4V, VREF=2.048, Gain= 64, Update Rate= 4.17Hz)
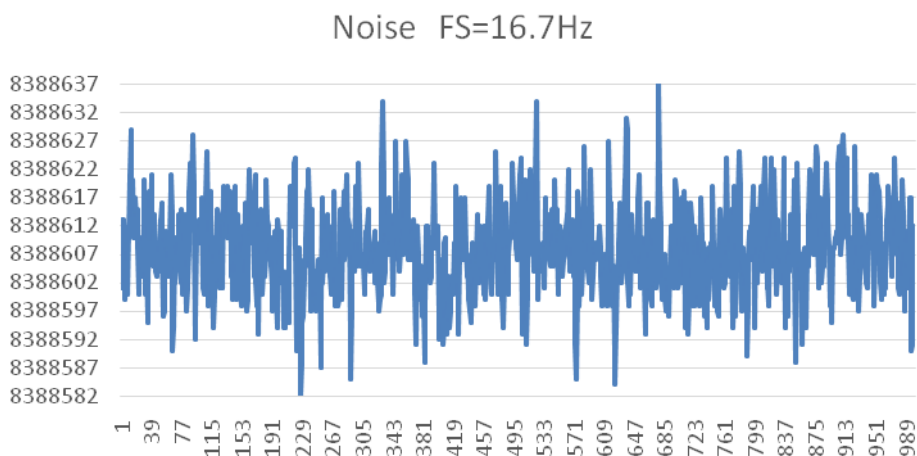
MS5199T Noise (AVDD=4V, VREF=2.048, Gain= 64, Update Rate=16.7Hz)

MS5199T Noise Distribution Histogram (AVDD=4V, VREF=2.048, Gain= 64, Update Rate= 16.7Hz)
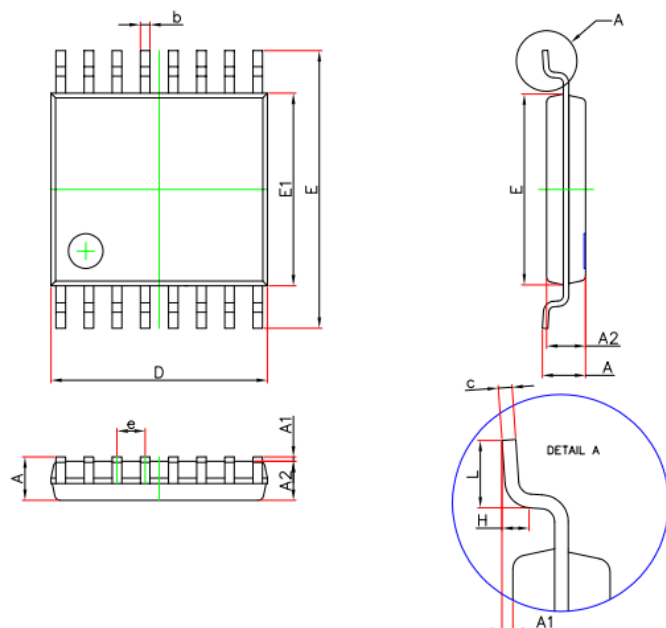
TYPICAL APPLICATION DIAGRAM

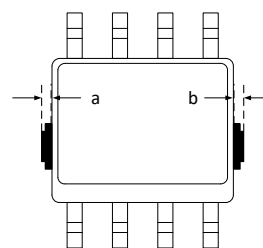The figure is a a connection diagram for weigh scale application for the MS5198T/MS5199T.

PACKAGE OUTLINE DIMENSIONS

TSSOP16

Note: In addition to the package size, a and b are allowed to have the maximum size of 0.15mm for waste glue simultaneously.

The diagram is as follows: taking SOP8 package as an example.

Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	-	1.200	-	0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	6.250	6.550	0.246	0.258
E1	4.300	4.500	0.169	0.177
e	0.650(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.250(TYP)		0.010(TYP)	
θ	1°	7°	1°	7°

MARKING and PACKAGING SPECIFICATION

1. Marking Drawing Description
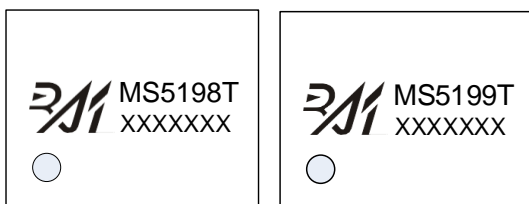
Product Name: MS5198T, MS5199T

Product Code: XXXXXXX

2. Marking Drawing Demand

Laser printing, contents in the middle, font type Arial.

3. Packaging Specification

Device	Package	Piece/Reel	Reel/Box	Piece/Box	Box/Carton	Piece/Carton
MS5198T	TSSOP16	3000	1	3000	8	24000
MS5199T	TSSOP16	3000	1	3000	8	24000

STATEMENT

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- When using Ruimeng products to design and produce, purchaser has the responsibility to observe safety

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  caused by potential failure risk.

- The process of improving product is endless. And our company would sincerely provide more excellent

  product for customer.

MOS CIRCUIT OPERATION PRECAUTIONS

Static electricity can be generated in many places. The following precautions can be taken to effectively prevent the damage of MOS circuit caused by electrostatic discharge:

1. The operator shall ground through the anti-static wristband.

2. The equipment shell must be grounded.

3. The tools used in the assembly process must be grounded.

4. Must use conductor packaging or anti-static materials packaging or transportation.

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