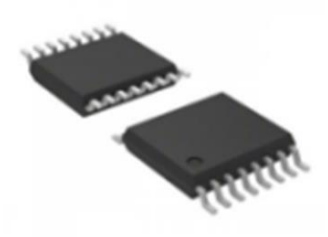
Low Noise, Low Power Dissipation, 16/24-Bit ∑-Δ ADC

PRODUCT DESCRIPTION

The MS5192TA/MS5193TA is a 16bit/24bit ADC with low power dissipation, low noise, three differential input channels. It integrates input buffer and low-noise instrumentation amplifier. When the gain is set to 64 and the update rate is 4.17Hz, the root mean square noise is 25nV. The MS5192TA/MS5193TA integrates internal band gap reference featured by high-precision, low noise and low drift. It can also use external differential reference voltage. The programmable excitation current source, burnout current source and bias voltage generator are also integrated. The bias voltage generator can set the channel common-mode voltage to 0.5×AVDD.

The chip uses an external clock or internal clock, and the output data rate can be set from 4.17Hz to 470Hz by register settings. The power supply ranges from 2.7V to 5.25V. The MS5192TA/MS5193TA is available in TSSOP16 package.



TSSOP16

FEATURES

- RMS Noise: 25nV @4.17Hz; 30nV@16.7Hz
- Power Dissipation: 350μA (Typ.)
- Integrated PGA
- Integrated Voltage Reference with Low Temperature Drift
- Update Rate: 4.17Hz to 470Hz
- Integrated 50Hz/60Hz Rejection Filter
- Integrated Programmable Current Source
- Integrated Bias Voltage Generator
- Power Supply: 2.7V to 5.25V
- Operating Temperature Range: -40°C to 105°C
- AEC-Q100 Qualified

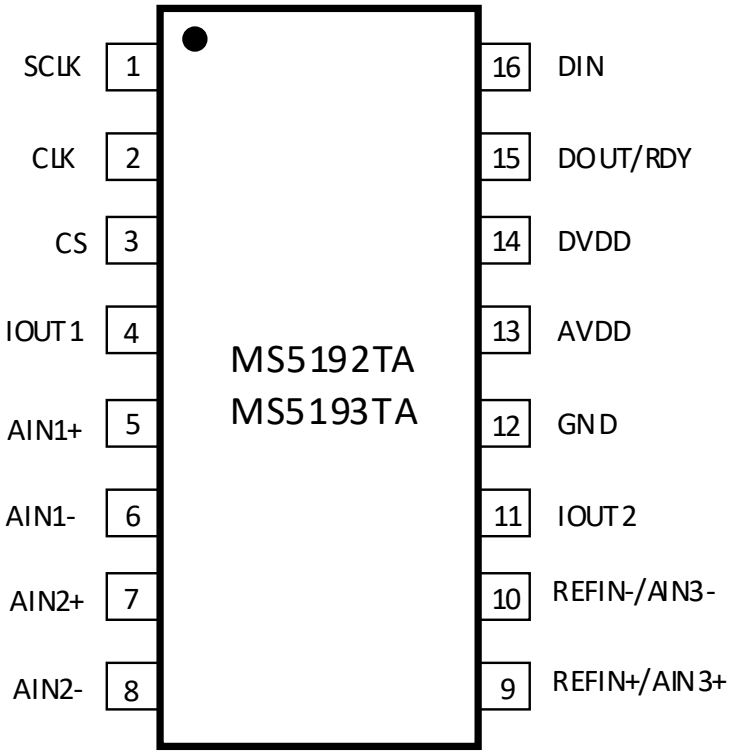
APPLICATIONS

- Thermocouple, 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
MS5192TA	TSSOP16	MS5192TA
MS5193TA	TSSOP16	MS5193TA

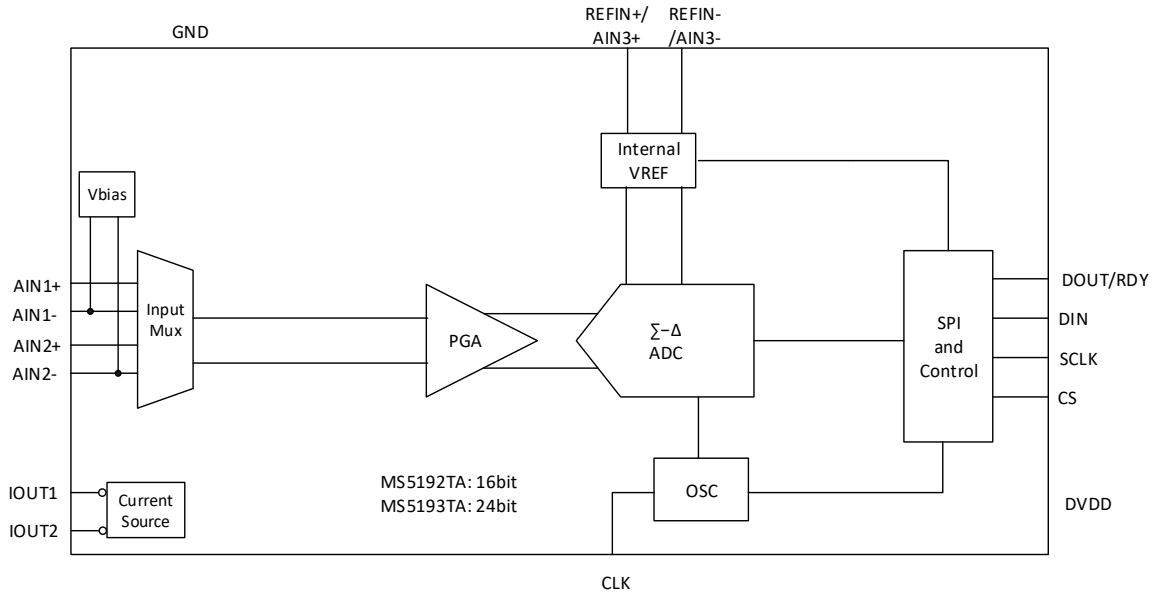
PIN CONFIGURATION



PIN DESCRIPTION

Pin	Name	Type	Description
1	SCLK	I	Serial Clock Input
2	CLK	I	Clock Input/Clock Output. Provide or Disable Internal Clock.
3	CS	I	Chip Select Input
4	IOUT1	O	Output Pin for Internal Excitation Current Source
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+/AIN3+	I	Positive Reference Voltage Input Pin. In addition, this pin can be used as analog channel 3 positive input
10	REFIN-/AIN3-	I	Negative Reference Voltage Input Pin. In addition, this pin can be used as analog channel 3 negative input
11	IOUT2	O	Output Pin for Internal Excitation Current Source
12	GND	I	Ground
13	AVDD	-	Analog Power Supply (2.7V to 5.25 V)
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



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	V_{AVDD}	-0.3 ~ +7.0	V
Digital Power Supply	V_{DVDD}	-0.3 ~ +7.0	V
Analog Input Voltage	V_{AIN}	-0.3 ~ V_{AVDD}+0.3	V
Reference Voltage	V_{REFIN}	-0.3 ~ V_{AVDD}+0.3	V
Digital Input Voltage		-0.3 ~ V_{DVDD}+0.3	V
Digital Output Voltage	$V_{(LE)}$	-0.3 ~ V_{DVDD}+0.3	V
Input Port Current		10	mA
Operating Temperature	T_A	-40 ~ 105	°C
Storage Temperature	T_{STG}	-65 ~ 150	°C
Soldering Temperature (10s)	T_{SOLDER}	260	°C
ESD (HBM)	V_{HBM}	±4000	V

ELECTRICAL CHARACTERISTICS

V_{AVDD}=2.7V to 5.25V, V_{DVDD}=2.7V to 5.25V, GND=0V, $V_{REFIN(+)}$=AVDD, $V_{REFIN(-)}$=0V.

Unless otherwise noted, T_A=25°C.

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			±150		ppm of FSR
Offset Error			±1		µV
Offset Error Temperature Drift			±10		nV/°C
Full-Scale Error			±10		µV
Gain Temperature Drift	External Reference, PGA=1~16		2		ppm/°C
	External Reference, PGA=32~128		5		
Power Supply Rejection	V_{AIN}=1V/gain, Gain>4		100		dB
Analog Input					
Differential Input Voltage		±VREF/gain			V
Common-Mode Voltage	V_{CM}= (V_{AINP} + V_{AINN})/2， Gain= 4 to 128	0.5			V
Analog Input Voltage	Disable Input Buffer, Gain=1 or 2	GND-30mV		V_{AVDD}+30mV	V
	Enable Input Buffer, Gain=1 or 2	GND+100mV		V_{AVDD} -100mV	V
	Enable Input Instrumentation Amplifier, Gain=4 to 128	GND+300mV		V_{AVDD}-1.1	V
Analog Input Current When Buffered Mode or Enable Internal Instrumentation Amplifier	Gain= 1 or 2, Update Rate < 100Hz		±1		nA
	Gain= 4 to 128, Update Rate < 100 Hz		±250		pA
	$V_{AIN3(+)}$/$V_{AIN3(-)}$, 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, V_{AIN} = 1 V/gain, Gain ≥ 4		100		dB
	50 ± 1 Hz, 60 ± 1Hz (FS[3:0] = 1010)		100		dB
	50 ± 1 Hz (FS[3:0] = 1001), 60 ± 1 Hz (FS[3:0] = 1000)		100		dB
Internal Reference Voltage					
Initial Resolution		1.16988		1.17012	V
Temperature Drift			10	15	ppm/°C
External Reference Voltage					
Reference Voltage		0.1	2.5	V_{AVDD}	V
Average Current			400		nA/V
Average Current Temperature Drift			±0.03		nA/V/°C
Common-mode Rejection			100		dB
Detection Level		0.3		0.65	V
Excitation Current Source (IEXC1, IEXC2)					
Output Current	Output Current 10μA	9.8	10	10.6	μA
	Output Current 210μA	197	210	220	
	Output Current 1000μA	970	1000	1030	
Temperature Drift			200		ppm/°C
Current Match			±0.5		%
Temperature Drift Match			50		ppm/°C

Parameter	Condition	Min	Typ	Max	Unit
Voltage Regulation			2		%/V
Load Regulation			0.2		%/V
Output Voltage	Output Current 10μA, 210μA	GND-30mV		V_{AVDD}-0.65	V
	Output Current 1mA	GND-30mV		V_{AVDD}-1.1	V
Temperature Sensor					
Accuracy			±2		°C
Sensitivity			0.82		mV/°C
Bias Voltage Generator					
Bias Voltage			V_{AVDD}/2		V
Clock					
Internal Clock Frequency			64±3%		kHz
Internal Clock Duty Cycle			50:50		%
External Clock Frequency			64		kHz
External Clock Duty Cycle		45:55		55:45	%
Logic Input					
CS Input Low Voltage	V_{DVDD}=5V			0.8	V
	V_{DVDD}=3V			0.4	V
CS Input High Voltage		2.0			V
SCLK and DIN Input High-level Threshold	V_{DVDD}=5V	1.6		2	V
	V_{DVDD}=3V	1.2		2	V
SCLK and DIN Input Low-level Threshold	V_{DVDD}=5V	0.8		1.45	V
	V_{DVDD}=3V	0.4		1.1	V
SCLK and DIN Input Hysteresis	V_{DVDD}=5V	0.1		0.17	V
	V_{DVDD}=3V	0.06		0.13	V
Input Current			±10		μA
Input Capacitance			10		pF

Parameter	Condition	Min	Typ	Max	Unit
Digital Logic Output					
Output High-level Voltage	V_{DVDD}=3V, I_{SOURCE}=100μA	V_{DVDD}-0.6			V
	V_{DVDD}=5V, I_{SOURCE}=200μA	4			V
Output Low-level Voltage	V_{DVDD}=3V, I_{SINK}=100μA			0.4	V
	V_{DVDD}=5V, I_{SINK}=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	V_{AVDD}=3V, Gain=128		300	400	μA
	V_{AVDD}=5V, Gain=128		350	400	μA
Shutdown Current				1	μA

OUTPUT NOISE and RESOLUTION (EXTERNAL REFERENCE)

The table below gives the output RMS noise for the MS5192TA and the MS5193TA 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. These data are typical values rounded to the nearest LSB.

Output RMS Noise (μV) VS. Gain and Update Rate for the MS5192TA and the MS5193TA with 2.5V Reference Voltage

Update Rate	Gain=1	Gain=2	Gain=4	Gain=8	Gain=16	Gain=32	Gain=64	Gain=128
4.17Hz	0.722	0.361	0.181	0.271	0.045	0.023	0.011	0.017
8.33Hz	0.722	0.361	0.181	0.090	0.090	0.045	0.034	0.017
16.7Hz	0.722	1.084	0.542	0.271	0.135	0.090	0.023	0.028
33.2Hz	1.445	1.084	0.542	0.361	0.181	0.068	0.034	0.034
62Hz	2.167	2.167	0.722	0.632	0.316	0.068	0.056	0.051
123Hz	2.890	3.251	0.903	0.813	0.361	0.158	0.056	0.062
242Hz	5.057	5.780	1.987	1.084	0.587	0.294	0.113	0.147
470Hz	6.502	5.419	2.348	1.174	0.587	0.429	0.169	0.119

Effective Resolution (Bits) VS. Gain and Update Rate for the MS5193TA with 2.5V Reference Voltage

Update Rate	Gain=1	Gain=2	Gain=4	Gain=8	Gain=16	Gain=32	Gain=64	Gain=128
4.17Hz	22.9	22.9	22.9	21.9	22.9	22.9	22.9	21.3
8.33Hz	22.8	21.9	22.9	22.9	21.9	21.2	21.3	21.3
16.7Hz	22.9	21.3	21.3	21.3	21.3	20.9	21.9	20.6
33.2Hz	21.9	21.3	21.3	20.9	20.9	21.3	21.3	20.3
62Hz	21.3	20.3	20.9	20.1	20.1	21.3	20.6	19.8
123Hz	20.9	19.8	20.6	19.8	19.9	20.1	20.6	19.5
242Hz	20.1	18.9	19.5	19.3	19.2	19.2	19.6	18.2
470Hz	19.8	19.0	19.2	19.2	19.2	18.7	19.0	18.5

Effective Resolution (Bits) VS. Gain and Update Rate for the MS5192TA with 2.5V Reference Voltage

Update Rate	Gain=1	Gain=2	Gain=4	Gain=8	Gain=16	Gain=32	Gain=64	Gain=128
4.17Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
8.33Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
16.7Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
33.2Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
62Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
123Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
242Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
470Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0

OUTPUT NOISE and RESOLUTION (INTERNAL REFERENCE)

The table below gives the output RMS noise for the MS5192TA and the MS5193TA with some update rates and gain settings. These data are for bipolar input range and 1.17V internal 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. These data are typical values rounded to the nearest LSB.

Output RMS Noise (μV) VS. Gain and Update Rate for the MS5192TA and the MS5193TA with 1.17V Reference Voltage

Update Rate	Gain=1	Gain=2	Gain=4	Gain=8	Gain=16	Gain=32	Gain=64	Gain=128
4.17Hz	0.607	0.553	0.260	0.200	0.112	0.047	0.025	0.025
8.33Hz	0.845	0.607	0.385	0.200	0.141	0.045	0.029	0.038
16.7Hz	1.257	1.528	0.396	0.366	0.167	0.083	0.030	0.031
33.2Hz	1.712	1.365	0.623	0.317	0.183	0.078	0.043	0.035
62Hz	2.363	2.363	0.759	0.447	0.219	0.110	0.070	0.059
123Hz	3.901	2.417	1.235	0.764	0.336	0.133	0.074	0.071
242Hz	5.267	6.762	1.804	0.986	0.607	0.261	0.110	0.105
470Hz	7.673	7.727	2.108	1.151	0.578	0.436	0.146	0.079

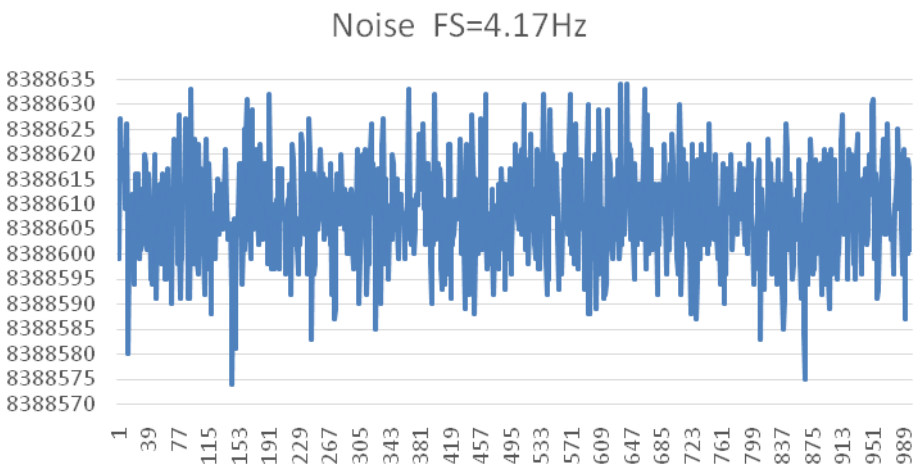
Effective Resolution (Bits) VS. Gain and Update Rate for the MS5193TA with 1.17V Reference Voltage

Update Rate	Gain=1	Gain=2	Gain=4	Gain=8	Gain=16	Gain=32	Gain=64	Gain=128
4.17Hz	22.7	21.8	21.9	21.3	21.1	21.4	21.3	20.3
8.33Hz	22.2	21.7	21.3	21.3	20.8	21.4	21.1	19.7
16.7Hz	21.6	20.4	21.3	20.4	20.5	20.5	21.0	20.0
33.2Hz	21.2	20.5	20.6	20.6	20.4	20.6	20.5	19.8
62Hz	20.7	19.7	20.4	20.1	20.2	20.1	19.8	19.0
123Hz	20.0	19.7	19.7	19.4	19.5	19.9	19.7	18.8
242Hz	19.6	18.2	19.1	19.0	18.7	18.9	19.2	18.2
470Hz	19.0	18.0	18.9	18.8	18.8	18.2	18.7	18.6

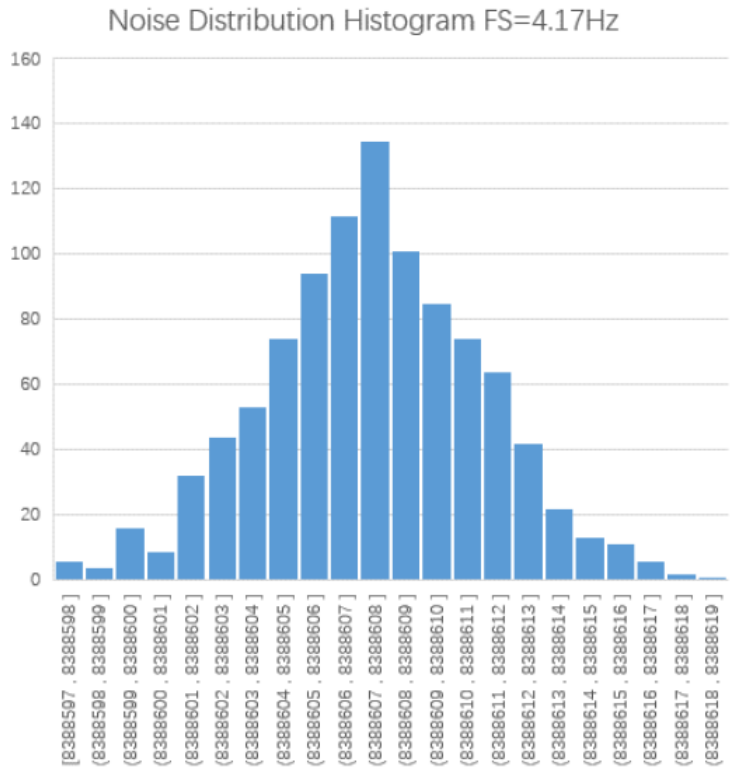
Effective Resolution (Bits) VS. Gain and Update Rate for the MS5192TA with 1.17V Reference Voltage

Update Rate	Gain=1	Gain=2	Gain=4	Gain=8	Gain=16	Gain=32	Gain=64	Gain=128
4.17Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
8.33Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
16.7Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
33.2Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
62Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
123Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
242Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
470Hz	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0

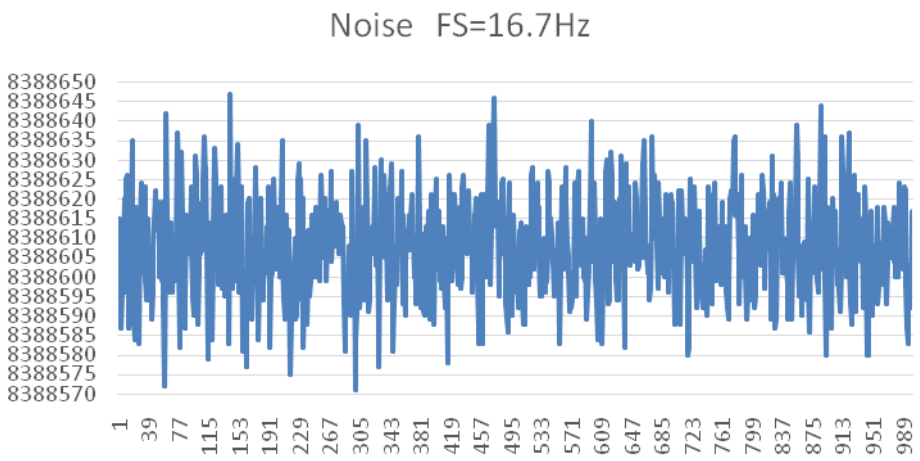
TYPICAL CHARACTERISTICS CURVES



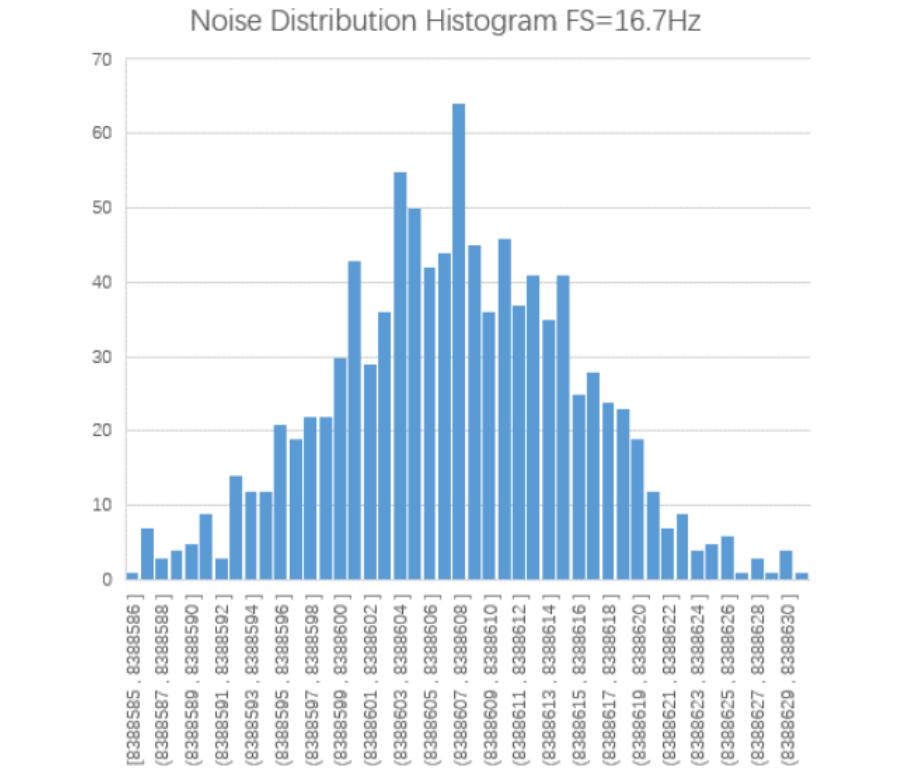
MS5193TA Noise (V_{AVDD}=4V, V_{REF}=2.048, Gain=64, Update Rate=4.17Hz)



MS5193TA Noise Distribution Histogram (V_{AVDD}=4V, V_{REF}=2.048, Gain= 64, Update Rate=4.17Hz)



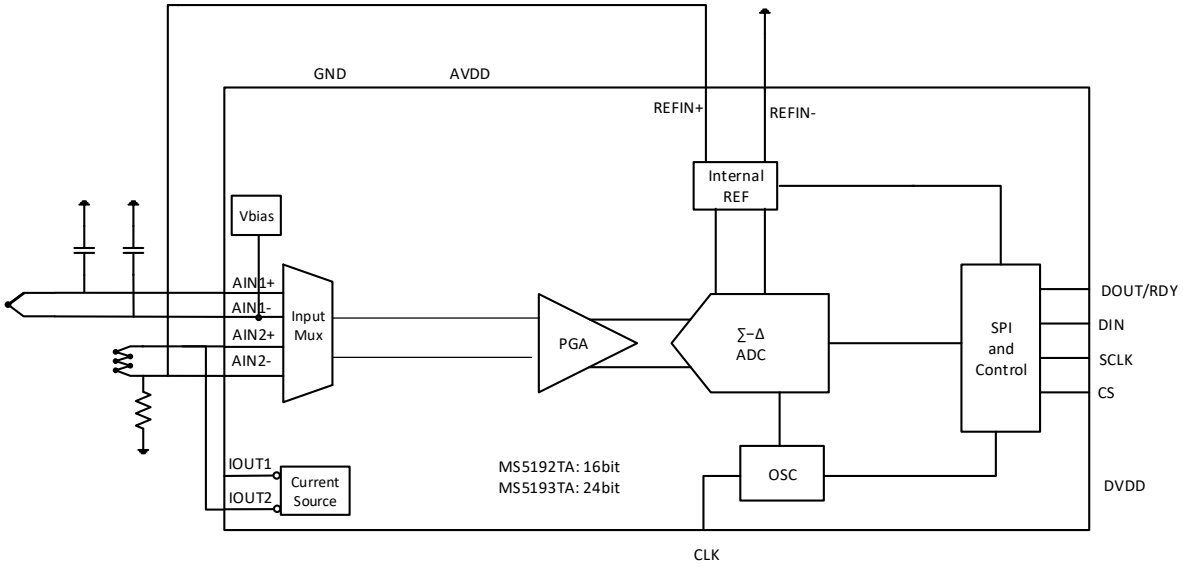
MS5193TA Noise (V_{AVDD}=4V, V_{REF}=2.048, Gain=64, Update Rate=16.7Hz)



MS5193TA Noise Distribution Histogram (V_{AVDD}=4V, V_{REF}=2.048, Gain=64, Update Rate=16.7Hz)

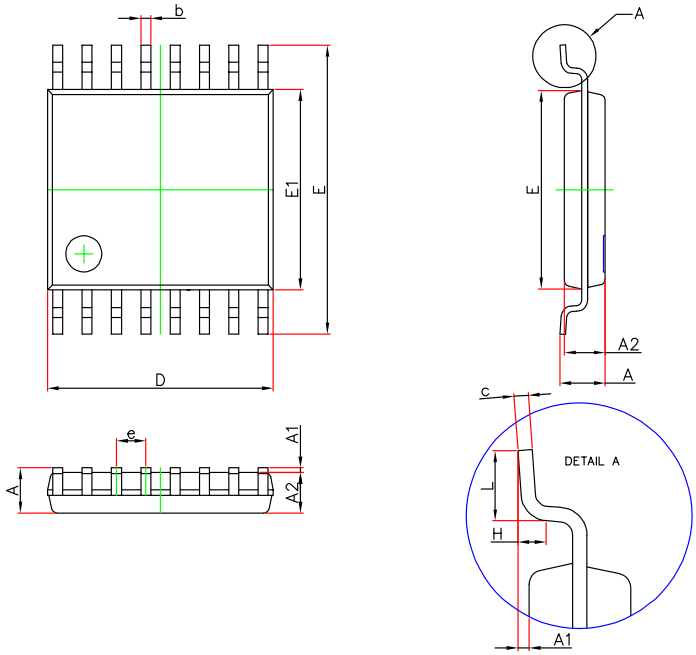
TYPICAL APPLICATION DIAGRAM

The figure is connection diagram for thermocouple measurement application for the MS5192TA/MS5193TA.



PACKAGE OUTLINE DIMENSIONS

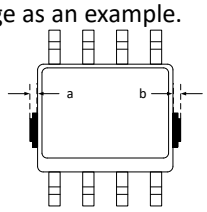
TSSOP16



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°

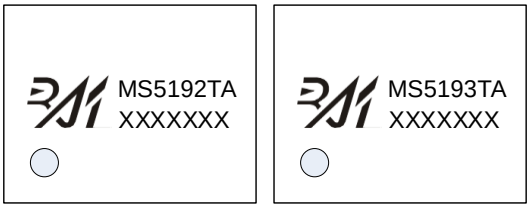
Note: In addition to the package size, a and b are allowed to have the maximum size of 0.15mm for waste glue simultaneously.

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



MARKING and PACKAGING SPECIFICATION

1. Marking Drawing Description



Product Name : MS5192TA, MS5193TA

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
MS5192TA	TSSOP16	3000	1	3000	8	24000
MS5193TA	TSSOP16	3000	1	3000	8	24000

STATEMENT

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- 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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