Isolation Σ-Δ Modulator

PRODUCT DESCRIPTION

The MS2400 is a second-order Σ-Δ modulator, an on-chip digital isolator, that converts analog input signals to high-speed 1-bit bitstream. The modulator continuously samples the input signal without requiring an external sample hold circuit. The full range of analog input signal is ±320mV with a maximum data rate of 10 MHz for the converted digital stream. The VDD1 of the MS2400 is powered by 5V power supply, and VDD2 can be powered by 5V or 3V power supply.

The serial interface uses digital isolation to provide better performance. The device has built-in reference voltage. The MS2400 is available in a 16-pin SOW package and the operating temperature range is -40°C to+125°C.

SOW16

FEATURES

- 10MHz Clock Rate
- 16 Bit No Missing Codes
- Typical INL at 16 bits： ±2LSB
- Offset Drift: 1uV/ °C
- On-chip Digital Isolator
- Integrated Reference Voltage
- ±250mV Analog Input Voltage (Full Range: ±320mV)
- Low Power Dissipation Operation
- Operating Temperature Range: -40°C to + 125°C
- SOW16 Package
- Input-to-Output Momentary Withstand Voltage
  60s Duration： 5kV RMS Standard

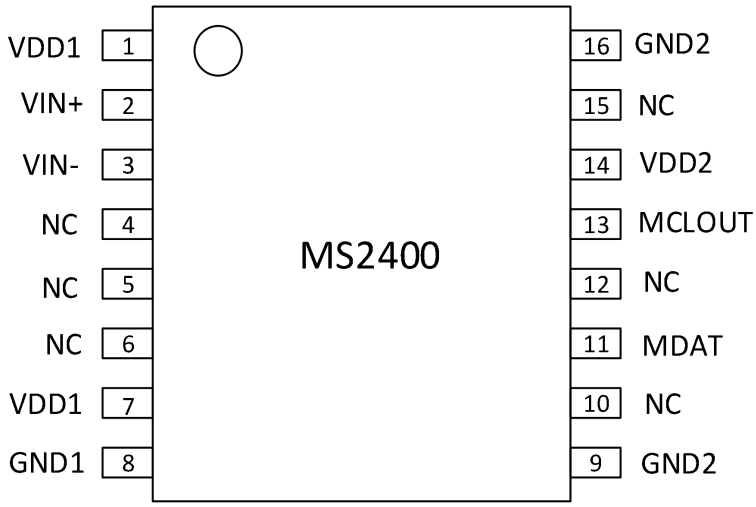
APPLICATIONS

- AC Motor Control

PRODUCT SPECIFICATION

Part Number	Package	Marking
MS2400	SOW16	MS2400

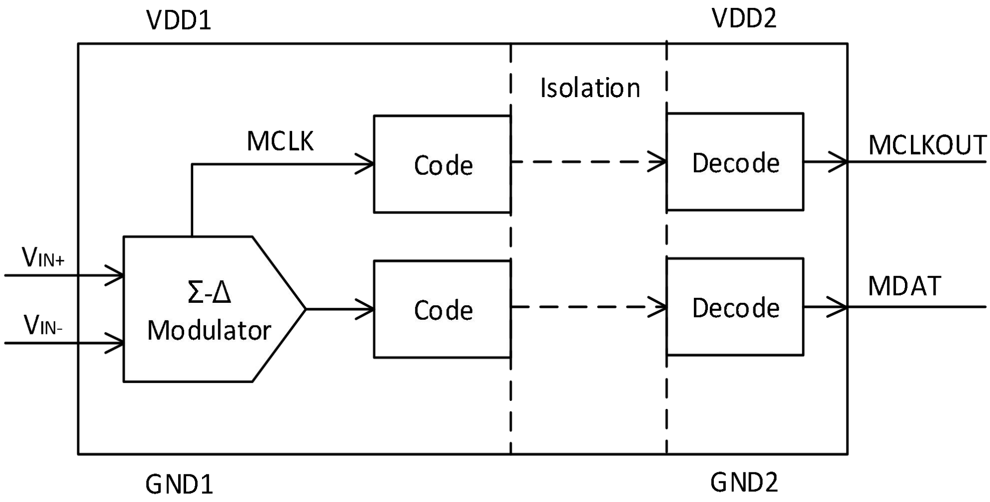
PIN CONFIGURATION



PIN DESCRIPTION

Pin	Name	Type	Description
1,7	VDD1	POWER	Isolated Side Power Supply
2	VIN+	I	Positive Analog Input , the rated range is ±250mV
3	VIN-	I	Negative Analog Input , usually connected to GND1
4,6,10,12,15	NC	-	Not Connection
8	GND1	I	Isolated Side Ground, this is the ground reference point for all circuits on the isolated side
9,16	GND2	I	Non-isolated Side Ground, this is the ground reference point for all circuits on the non-isolated side
11	MDAT	O	Serial Data Output, the output signal of the internal modulator is in the form of serial data stream, which is output from the pin to the outside. Each bit is displaced along the MCLKOUT rising edge and is valid on the next MCLKOUT rising edge
13	MCLKOUT	O	Master Clock Output, maximum frequency is 10MHz, MDAT output stream is valid on MCLKOUT rising edge
14	VDD2	POWER	Non-Isolated Side Power Supply

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
Isolated Side Power Supply	VDD1-GND1	-0.3 ~ 6.5	V
Non-Isolated Side Power Supply	VDD2-GND2	-0.3 ~ 6.5	V
Analog Input Voltage to GND1	VIN-GND1	-0.3 ~ VDD1+0.3	V
Output Voltage to GND2	$V_{MDAT}/V_{MCLKOUT}$-GND2	-0.3 ~ VDD2+0.3	V
Input Current (Except Power Pin)	I_I	±10mA	mA
Storage Temperature Range	Tstg	-65 ~ +150	°C
Junction Temperature	$T_{J(MAX)}$	150	°C
Input to Output Resistance	R_{I-O}	10^{12}	Ω
Input to Output Capacitance	C_{I-O}	2	pF
Lead Temperature (10s)	$T_{SOLDERING}$	260	°C
ESD(HBM)	ESD(HBM)	±3000	V

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Isolated Side Power Supply	VDD1	4.5		5.5	V
Non-Isolated Side Power Supply	VDD2	3		5.5	V
Operating Temperature Range	T_A	-40		+125	°C

ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Static Characteristic						
Resolution		Filter output truncated to 16 bit	16			Bits
Integral Nonlinearity	INL	V_{IN+}=±200mV,T_A= -40°C~+85°C		±1.5	±7	LSB
		V_{IN+}=±250mV,T_A= -40°C~+85°C		±2.0	±13	
		V_{IN+}=±200mV,T_A= -40°C~+125°C		±1.5	±11	
		V_{IN+}=±250mV,T_A= -40°C~+125°C		±2	±46	
Differential Nonlinearity	DNL	V_{IN+}= -250mV~250mV, Ensure 16-bit no missing codes			±0.9	LSB
Offset Voltage	V_{OS}	V_{IN+}= -250mV~250mV		±0.25	±0.5	mV
Offset Voltage Temperature Drift	TC_{VOS}			1	3.5	µV/°C
Offset Voltage Supply Drift	VC_{VOS}			120		µV/V
Gain Error	GERR	V_{IN+}= -250mV~250mV		0.07	±1.5	mV
Gain Error Temperature Drift	TC_{GERR}			23		µV/°C
Gain Error Supply Drift	VC_{GERR}			110		µV/V
Analog Input						
Input Voltage Range	V_{IN+}-V_{IN-}	Meet specific characteristics, Full Range ±320mV		±200	±250	mV
Dynamic Input Current	I_{IA}	V_{IN+}= 500mV, V_{IN-}=0V		±13	±18	µA
		V_{IN+}= 400mV, V_{IN-}=0V		±10	±15	
		V_{IN+}= 0V, V_{IN-}=0V		0.08		
DC Leakage Current	I_{IL}			±0.01	±0.6	µA
Input Capacitance	C_{IA}			10		pF
Dynamic Characteristic VIN+= 5kHz						
Signal-to-(Noise +Distortion) Ratio	SINAD	V_{IN+}=±200mV, T_A= -40°C~+85°C	76	82		dB
		V_{IN+}=±250mV, T_A= -40°C~+85°C	71	82		
		V_{IN+}=±200mV, T_A= -40°C~+125°C	72	82		
		V_{IN+}=±250mV, T_A= -40°C~+125°C		82		
Signal-to-Noise Ratio	SNR	V_{IN+}=±250mV, T_A= -40°C~+125°C	81	83		dB
		V_{IN+}=±200mV, T_A= -40°C~+125C	80	82		dB

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Total Harmonic Distortion	THD	V_{IN+}=-250mV~250mV		-90		dB
Spurious Freedynamic Range	SFDR			-92		dB
Effective Number of Bits	ENOB		12.3	13.3		Bits
Isolation Transient Immunity	CMTI		25	30		kV/μs
Logic Input						
Input High Voltage	V_{IH}		0.8×VDD2			V
Input Low Voltage	V_{IL}			0.2×VDD2		V
Input Current	I_{IN}				±0.5	μA
Leakage Current, Floating State	I_{FSL}				1	μA
Input Capacitance	C_{ID}				10	pF
Logic Output						
Output High Voltage	V_{OH}	I_O= -200μA	VDD2-0.1			V
Output Low Voltage	V_{OL}	I_O= +200μA			0.4	V
Power Requirement						
Isolated Side Power Supply	VDD1		4.5		5.5	V
Non-isolated Side Power Supply	VDD2		3		5.5	V
Isolated side Power Supply Current	I_{DD1}	VDD1=5.5V		15	18	mA
Non-isolated side Power Supply Current	I_{DD2}	VDD2=5.5V		7	9	mA
		VDD2=3.3V		3	4	
Power Dissipation	P_D	VDD1=VDD2=5.5V		93.5		mW
Timing Specification						
Master Clock Frequency	$f_{MCLKOUT}$		9	10	11	MHz
Data Access Time	t_{ACESS}				25	ns
Data Hold Time	t_{HOLD}		15			ns
Input Clock Duty Cycle	DR	$f_{MCLKOUT}$ = 10MHz	40%		60%	-

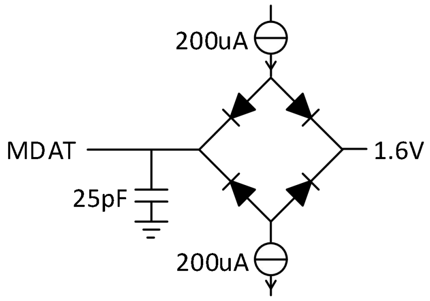
Insulation and Safety Related Specifications

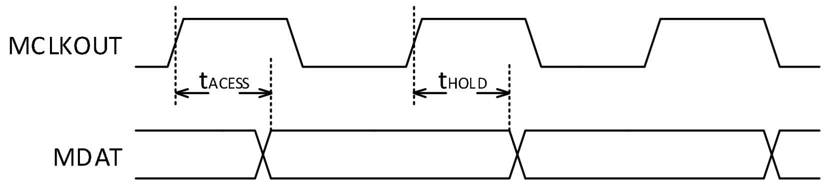
Parameter	Symbol	Condition	Value	Unit
Input-to-Output Momentary Withstand Voltage	V_{ISO}	60s duration	5000	Vrms
Minimum External Air Gap	L(I01)	Measured from input terminals to output terminals, shortest distance through air	7.8	mm
Minimum External Tracking	L(I02)	Measured from input terminals to output terminals, shortest distance path along body	7.8	mm
Minimum Internal Gap	d_{ISO}	Insulation distance through insulation	0.018	mm

(1) Unless otherwise noted, VDD1=4.5V to 5.5V, VDD2=3V to 5.5V, V_{IN+}=-200mV to +200mV, V_{IN-}=0V (single end); T_A=-40°C to +125°C, f_{MCLK} = 10MHz, test using Sinc3 filter defined by Verilog, decimation rate=256.

(2) All the voltages refer to their respective ground.

(3) The load circuit for the measurement timing specification is shown below, and the time is defined as the required time for the output to span 0.8V-2.0V.

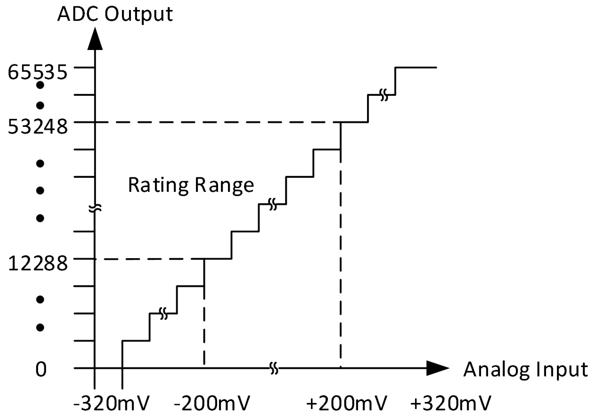




APPLICATIONS INFORMATION

Analog Input

The MS2400 is able to convert the input signal to the output stream through a second-order modulator stage. In order to reconstruct the initial information, it is required to digital filtering and decimation processing. And Sinc3 filter is recommended. Assuming applying internal clock frequency of 10 MHz, if the decimation rate is 256, the resulting 16-bit word rate is 39 kHz. In 16-bit output mode, the transfer function of the MS2400 is shown below.



Digital Filter

The resolution and throughput of the entire system depend on the selected filter and the used decimation rate. The higher the decimation rate, the higher the system accuracy . However, there is a trade-off between accuracy and throughput, so the higher decimation rate results in the solutions with lower throughput. It is recommended that the MS2400 be used with a Sinc3 filter.

Grounding and Layout

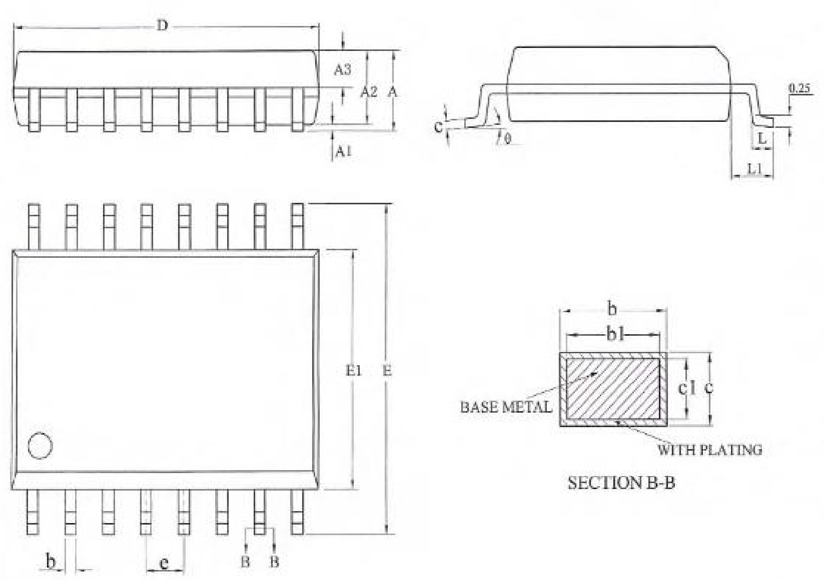
It is recommended to connect 100nF power decoupling capacitors on VDD1 and VDD2 respectively. In applications with high common-mode transients, it is important to ensure minimal circuit board coupling on both terminals of the isolation grid. In addition, when laying out the circuit board, it is important to consider that no coupling will occur and affect all pins on the side of particular device. If design demands are not meet, the voltage difference between pins would exceed the absolute rating, which causes device latch-up and permanent damage. Decoupling capacitor should be as close to the power pin as possible. The series resistance of analog input should be as minimized as possible to avoid signal distortion (specially in high temperature condition). If possible, it should ensure that source impedance is equal on each analog input pin to reduce offset error. It is noted that the mismatch and thermocouple have effect on PCB traces of the analog input so as to reduce offset drift.

Isolation Lifetime

All isolation structures are easy to break down under long-term use or over-high voltage. It should also be noted that the lifetime of the MS2400 varies with waveform type applied to the isolation structure. Integrated digital isolation structure decays at different rates, depending on whether the waveform is bipolar AC, unipolar AC or DC.

PACKAGE OUTLINE DIMENSIONS

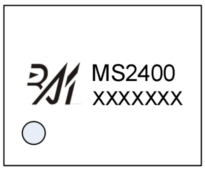
SOW16



Symbol	Dimensions in Millimeters		
	Min	Typ	Max
A	-	-	2.65
A1	0.10	-	0.30
A2	2.25	2.30	2.35
A3	0.97	1.02	1.07
b	0.35	-	0.44
b1	0.34	0.37	0.39
c	0.25	-	0.31
c1	0.24	0.25	0.26
D	10.10	10.30	10.50
E	10.26	10.41	10.60
E1	7.30	7.50	7.70
e	1.27BSC		
L	0.55	-	0.85
L1	1.40BSC		
θ	0	-	8°

MARKING and PACKAGING SPECIFICATIONS

1. Marking Drawing Description



Product Name : MS2400

Product Code : XXXXXXX

2. Marking Drawing Demand

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

3. **Packaging Specifications**

Device	Package	Piece/Reel	Reel/Box	Piece/Box	Box/Carton	Piece/Carton
MS2400	SOW16	1000	8	8000	1	8000

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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