Isolation Σ-Δ Modulator

PRODUCT DESCRIPTION

The MS2401 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 holding circuit. The analog signal input full range is ±320mV with a maximum data rate of 20 MHz for the converted digital stream. The VDD1 of MS2401 is powered by 5V power supply, and the VDD2 can be powered by 5V or 3V power supply.

The serial interface uses on-chip digital isolation to provide better performance. The device has a built-in reference voltage. The MS2401 is available in a 16-pin SOW package and the operating temperature range is -40°C to+125°C.

SOW16

FEATURES

- 16 Bit No Missing Code
- Typical INL at 16 bits: ±4LSB
- Offset Drift: 1μV/ °C
- Maximum External Clock Rate: 20MHz
- On-chip Digital Isolator
- Integrated Reference Voltage
- ±250mV Analog Input Voltage (Full Range：±320mV)
- Low Power Consumption Operation
- Operating Temperature Range: -40°C to + 125°C
- SOW16 Package
- Input-to-Output Momentary Withstand Voltage
  60s Duration：5000Vrms

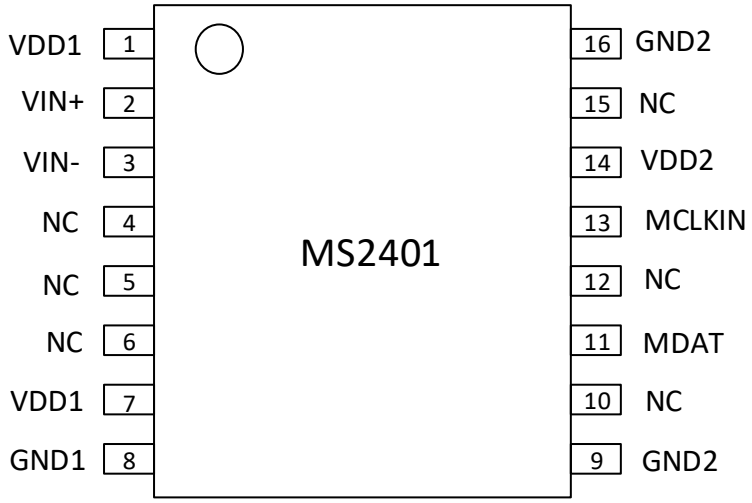
APPLICATIONS

- AC Motor Control

PRODUCT SPECIFICATION

Part Number	Package	Marking
MS2401	SOW16	MS2401

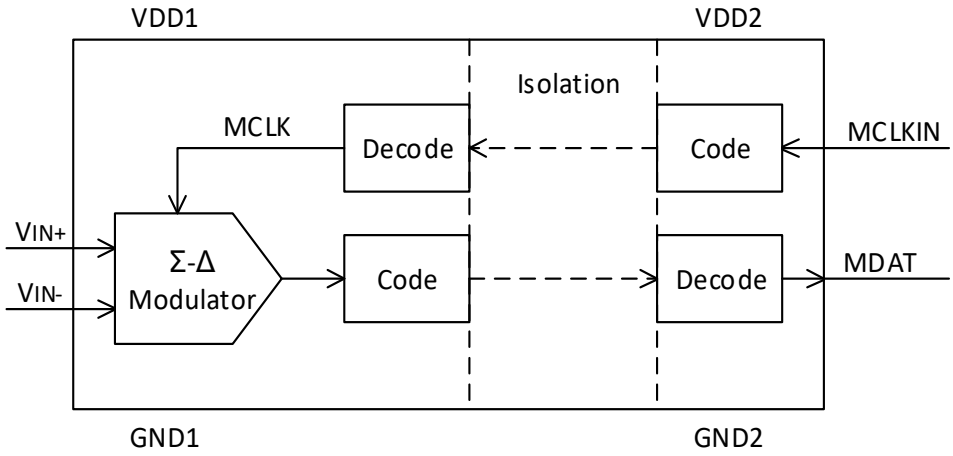
PIN CONFIGURATION



PIN DESCRIPTION

Pin	Name	Type	Description
1,7	VDD1	-	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
4,5,6,10,12,15	NC	-	Not Connection
8	GND1	-	Isolated Side Ground, this is the ground reference point for all circuits on the isolated side
9,16	GND2	-	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 MCLKIN rising edge and is valid on the next MCLKIN rising edge
13	MCLKIN	I	Master Clock Input, maximum frequency is 20MHz, MDAT output stream is valid on MCLKIN rising edge
14	VDD2	-	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	V_{DD1}-GND1	-0.3 ~ 6.5	V
Non-Isolated Side Power Supply	V_{DD2}-GND2	-0.3 ~ 6.5	V
Analog Input Voltage to GND1	V_{IN}-GND1	-0.3 ~ V_{DD1}+0.3	V
Digital Input Voltage to GND2	V_{MCLKIN}-GND2	-0.3 ~ V_{DD1}+0.5	V
Output Voltage to GND2	V_{MDAT}-GND2	-0.3 ~ V_{DD2}+0.3	V
Input Current (Except Power Pin)	I_I	±10	mA
Storage Temperature Range	T_{STG}	-65 ~ +150	°C
Maximum Junction Temperature	$T_{J(MAX)}$	150	°C
Input to Output Resistance	R_{I-O}	1012	Ω
Input to Output Capacitance	C_{I-O}	1.7	pF
Lead-Free Temperature (10s)	$T_{SOLDERING}$	260	°C
ESD(HBM)	V_{ESD}	±3000	V

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Isolated Side Power Supply	V_{DD1}	4.5		5.5	V
Non-Isolated Side Power Supply	V_{DD2}	3		5.5	V
Operating Temperature Range	T_A	-40		+125	°C

ELECTRICAL CHARACTERISTICS

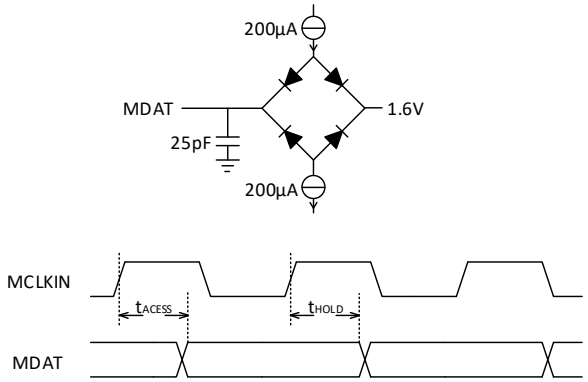
Parameter	Symbol	Condition	Min	Typ	Max	Unit
Static Performance						
Resolution		Filter output truncated to 16 bit	16			Bits
Integral Nonlinearity	INL	V_{IN+}=±200mV, f_{MCLKIN}=20MHz		±1.5	±7	LSB
		V_{IN+}=±250mV, f_{MCLKIN}=20MHz		±4.0	±13	
Differential Nonlinearity	DNL	V_{IN+}= -250mV~250mV, f_{MCLKIN}=20MHz			±0.9	LSB
Offset	V_{OS}	V_{IN+}= -250mV~250mV, f_{MCLKIN}=20MHz		±0.25	±0.5	mV
Offset Drift VS. Temperature	TC_{VOS}			1	3.5	µV/°C
Offset Drift VS. VDD1	VC_{VOS}			120		µV/V
Gain Error	G_{ERR}	V_{IN+}= -250mV~250mV, f_{MCLKIN}=20MHz		0.07	±1.5	mV
Gain Error Drift VS.Temperature	TC_{GERR}			23		µV/°C
Gain Error Drift VS. VDD1	VC_{GERR}			110		µV/V
Analog Input						
Input Voltage Range	V_{IN+}-V_{IN-}	Full Range ±320mV		±200	±250	mV
Dynamic Input Current	I_{IA}	V_{IN+}= 500mV, V_{IN-}=0V f_{MCLKIN}=20MHz		±13	±18	µA
		V_{IN+}= 400mV, V_{IN-}=0V f_{MCLKIN}=20MHz		±10	±15	
		V_{IN+}= 0V, V_{IN-}=0V, f_{MCLKIN}=20MHz		0.08		
DC Leakage Current	I_{IL}			±0.01	±0.6	µA
Input Capacitance	C_{IA}			10		pF
Dynamic Specifications V_{IN+}= 5kHz						
Signal-to-(Noise +Distortion) Ratio	SINAD	V_{IN+}=±200mV, f_{MCLKIN}=5~20MHz, T_A= 25°C	76	82		dB
		V_{IN+}=±250mV, f_{MCLKIN}=5~20MHz, T_A= 25°C	71	82		
Signal-to-Noise Ratio	SNR	V_{IN+}=±250mV, f_{MCLKIN}=5~20MHz, T_A= 25°C	81	83		dB
		V_{IN+}=±200mV, f_{MCLKIN}=5~20MHz, T_A= 25°C	80	82		dB

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Total Harmonic Distortion	THD	V_{IN+}= -250mV~250mV, f_{MCLKIN}=20MHz		-90		dB
Spurious Free Dynamic Range	SFDR			-92		dB
Effective Number of Bits	ENOB		12.3	13.3		Bits
Isolation Transient Immunity	CMTI		25	30		kV/μs
Logic Inputs						
Input High Voltage	V_{IH}		0.8× V_{DD2}			V
Input Low Voltage	V_{IL}				0.2× V_{DD2}	V
Input Current	I_{IN}				±0.5	μA
Leakage Current	I_{FSL}				1	μA
Input Capacitance	C_{ID}				10	pF
Logic Outputs						
Output High Voltage	V_{OH}	I_O= -200μA	V_{DD2}- 0.1			V
Output Low Voltage	V_{OL}	I_O= +200μA			0.4	V
Power Requirements						
Isolated Side Power Supply	V_{DD1}		4.5		5.5	V
Non-isolated Side Power Supply	V_{DD2}		3		5.5	V
Isolated Side Power Supply Current	I_{DD1}	V_{DD1}=5.5V		14	16	mA
Non-isolated Side Power Supply Current	I_{DD2}	V_{DD2}=5.5V		7	9	mA
		V_{DD2}=3.3V		3	4	
Power Dissipation	P_D	V_{DD1}=V_{DD2}=5.5V		93.5		mW
Timing Specifications						
Master Clock Input Frequency	f_{MCLKIN}		5		20	MHz
Data Access Time after MCLK Rising Edge	t_{ACESS}				25	ns
Data Hold Time after MCLK Rising Edge	t_{HOLD}		15			ns
Clock Low to High Time	DR	f_{MCLKIN} ≤ 16MHz	40%		60%	
		16MHz < f_{MCLKIN} ≤20MHz and V_{DD1}=V_{DD2}=5V±0.5%	48%		52%	

Insulation and Safety Related Specifications				
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. All the voltages refer to their respective places.

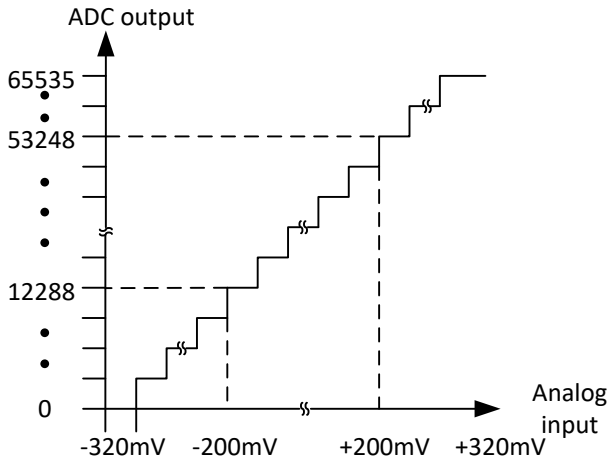
2. The load circuit for the measurement sequence specification is shown below, and time is defined as the time required for the output to span 0.8V-2.0V.



APPLICATIONS INFORMATION

Analog Input

The MS2401 is able to convert the input signal to the output stream through a second-order modulator stage. In order to reconstruct the original information, it is required to digital filtering and decimation processing. And Sinc3 filter is recommended. Assuming an external clock frequency of 16 MHz, if the decimation rate is 256, the resulting 16-bit word rate is 62.5 kHz. In 16-bit output mode, the transfer function of the MS2401 is shown below.



Digital Filter

The resolution and throughput of the system depend on the selected filter and the used decimation rate . The higher the decimation rate, the higher the accuracy of the system. However, there is a trade-off between accuracy and throughput, so the higher decimation rates yield solutions with lower throughput. It is recommended that the MS2401 be used with a Sinc3 filter.

Grounding and Layout

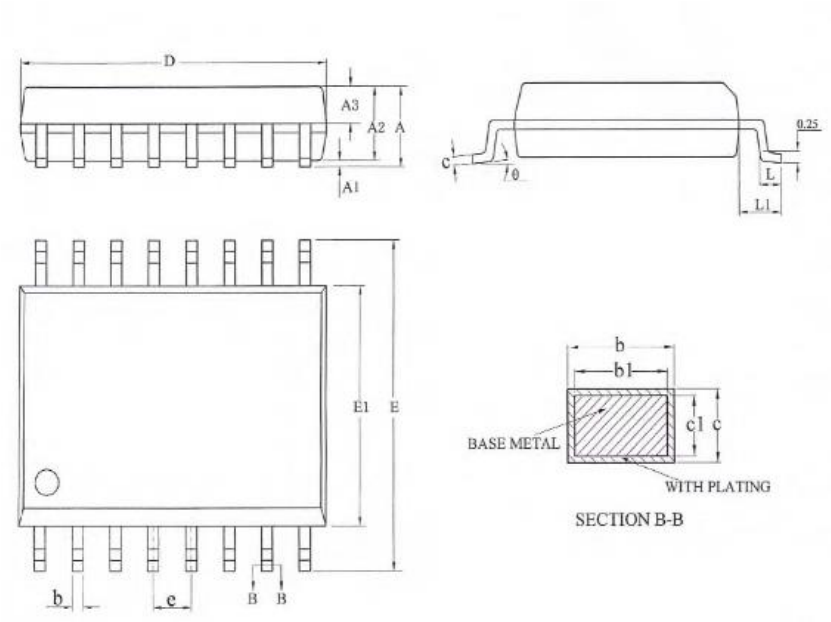
It is recommended to connect 100nF power decoupling capacitors at VDD1 and VDD2 respectively. In applications with high common mode transients, it is important to ensure minimal circuit board coupling at both terminals of the isolation grid. In addition, when laying out the circuit board, it is important to consider that no coupling will occur and affect all pins on the side of a particular device. Decoupling capacitor should be as close to the power pin as possible.The series resistance of analog input should be minimized to avoid signal distortion .

Isolation Lifetime

All isolation structures are easy to break down under long-term use or high voltage. It should also be noted that the lifetime of the MS2401 varies with waveform type applied to the isolation structure. Integrated digital isolation structures decay at different rates, depending on whether the waveform is bipolar, unipolar, or DC.

PACKAGE OUTLINE DIMENSIONS

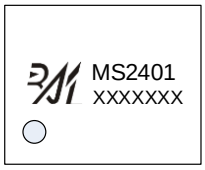
SOW16



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 SPECIFICATION

1. Marking Drawing Description



Product Name: MS2401

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
MS2401	SOW16	1000	1	1000	8	8000

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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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