

## Low Power Dissipation Operational Amplifier

### PRODUCT DESCRIPTION

The MS321, MS358, MS324 are single channel, dual channel, four channel amplifiers respectively. It has high unit gain bandwidth and the slew rate could be up to  $0.4V/\mu s$  on specific condition. Each amplifier only has  $430\mu A$  quiescent current at 5V. The input common-mode range could be grounded. In addition, the device supports single or dual power operation, and easily drive large capacitance load.

The MS321, MS358, MS324 have lead SOT23-5, SOP8, SOP14/TSSOP14 and QFN16 packages respectively. The device is featured by low power dissipation, wide power supply range and economical price, allowing it to be applied widely.

### FEATURES

- Gain Bandwidth :  $1MHz@25^{\circ}C$
- Low Power Supply Current:  $430\mu A$
- Low Input Bias Current:  $30nA$
- Power Supply Range: 2.5V to 36V
- Maintain Stable in Large Capacitance Load

### APPLICATIONS

- Charger
- Power Supply
- Industrial Control Tools
- Desktop Computer
- Communication

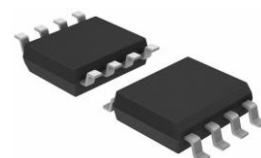
### PRODUCT SPECIFICATION

Part Number	Package	Marking
MS321	SOT23-5	321
MS358	SOP8	MS358
MS324	SOP14	MS324
MS324T	TSSOP14	MS324T
*MS324N	QFN16	MS324N

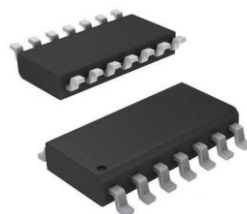
\* The package is not available temporarily. If necessary, please contact Hangzhou Ruimeng Sales Department Center.



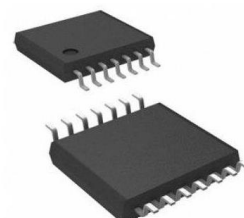
SOT23-5



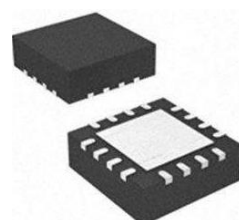
SOP8



SOP14

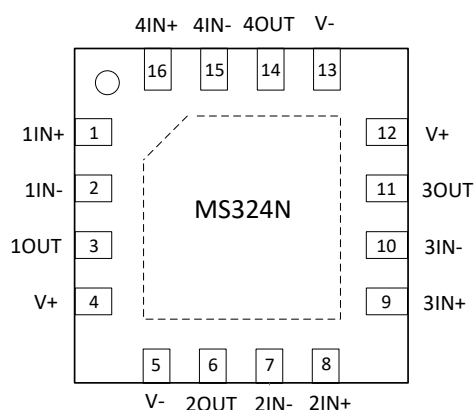
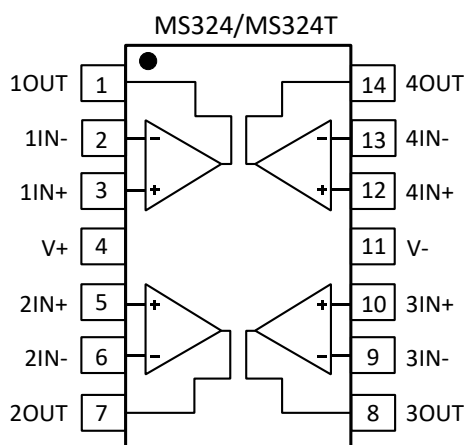
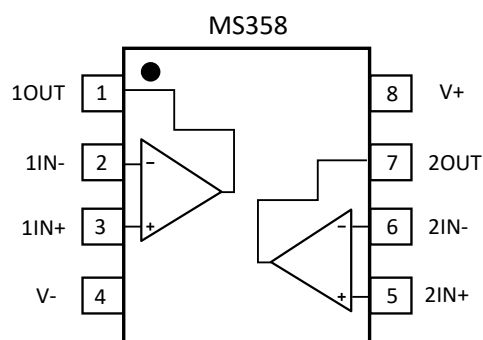
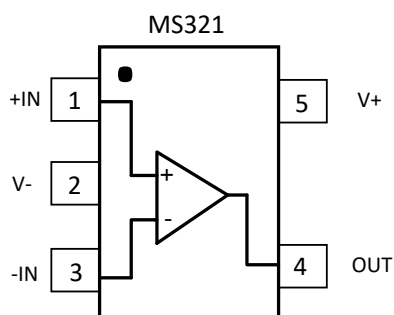


TSSOP14



QFN16

## PIN CONFIGURATION



## PIN DESCRIPTION

Pin	Name	Type	Description
<b>MS321</b>			
1	+IN	I	Non-inverting Input
2	V-	-	Negative Power Supply
3	-IN	I	Inverting Input
4	OUT	O	Channel Output
5	V+	-	Positive Power Supply
<b>MS358</b>			
1	1OUT	O	Channel 1 Output
2	1IN-	I	Inverting Input (Channel 1)
3	1IN+	I	Non-inverting Input (Channel 1)
4	V-	-	Negative Power Supply
5	2IN+	I	Non-inverting Input (Channel 2)
6	2IN-	I	Inverting Input (Channel 2)
7	2OUT	O	Channel 2 Output
8	V+	-	Positive Power Supply
<b>MS324/MS324T</b>			
1	1OUT	O	Channel 1 Output
2	1IN-	I	Inverting Input (Channel 1)
3	1IN+	I	Non-inverting Input (Channel 1)
4	V+	-	Positive Power Supply
5	2IN+	I	Non-inverting Input (Channel 2)
6	2IN-	I	Inverting Input (Channel 2)
7	2OUT	O	Channel 2 Output
8	3OUT	O	Channel 3 Output
9	3IN-	I	Inverting Input (Channel 3)
10	3IN+	I	Non-inverting Input (Channel 3)
11	V-	-	Negative Power Supply
12	4IN+	I	Non-inverting Input (Channel 4)
13	4IN-	I	Inverting Input (Channel 4)
14	4OUT	O	Channel 4 Output

Pin	Name	Type	Description
<b>MS324N</b>			
1	1IN+	I	Non-inverting Input (Channel 1)
2	1IN-	I	Inverting Input (Channel 1)
3	1OUT	O	Channel 1 Output
4	V+	-	Positive Power Supply
5	V-	-	Negative Power Supply
6	2OUT	O	Channel 2 Output
7	2IN-	I	Inverting Input (Channel 2)
8	2IN+	I	Non-inverting Input (Channel 2)
9	3IN+	I	Non-inverting Input (Channel 3)
10	3IN-	I	Inverting Input (Channel 3)
11	3OUT	O	Channel 3 Output
12	V+	-	Positive Power Supply
13	V-	-	Negative Power Supply
14	4OUT	O	Channel 4 Output
15	4IN-	I	Inverting Input (Channel 4)
16	4IN+	I	Non-inverting Input (Channel 4)

**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	Ratings	Unit
Differential Input Voltage	$\pm$ Power Supply	
Input Current ( $V_{IN} < -0.3V$ )	50	mA
Power Supply ( $V+ - V-$ )	40	V
Input Voltage	-0.3 ~ 40	V
Junction Temperature	150	°C
Operating Temperature	-40 ~ 125	°C
Soldering Temperature (10s)	260	°C
Storage Temperature ( $T_{STG}$ )	-65 ~ 150	°C

## ELECTRICAL CHARACTERISTICS

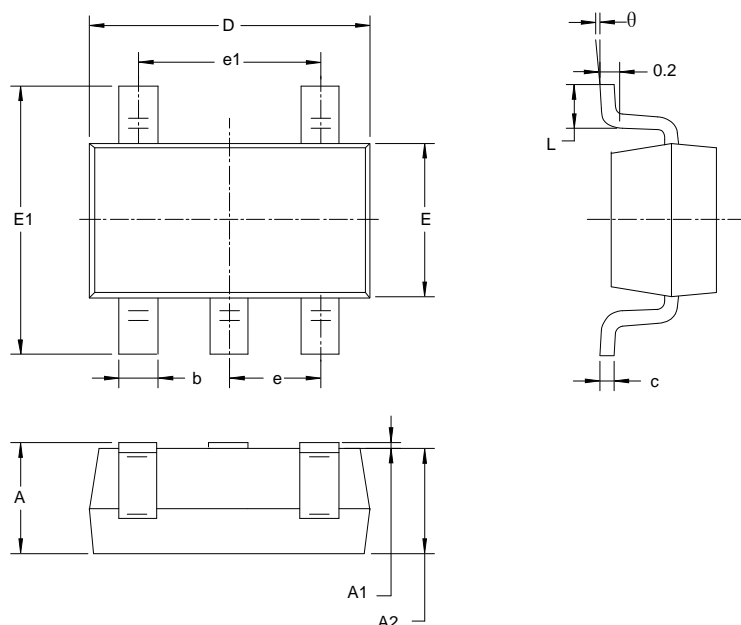
Unless otherwise noted,  $T_A=25^{\circ}\text{C}$ ,  $V_+=5\text{V}$ ,  $V_-=0\text{V}$ ,  $V_O=1.4\text{V}$ .

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Characteristics						
Input Offset Voltage	V <sub>OS</sub>	T <sub>A</sub> =25°C		2	7	mV
		-40°C ≤ T <sub>A</sub> ≤125°C			9	
Input Bias Current	I <sub>B</sub>	T <sub>A</sub> =25°C		30	250	nA
		-40°C ≤ T <sub>A</sub> ≤125°C			500	
Input Offset Current	I <sub>OS</sub>	T <sub>A</sub> =25°C		5	50	nA
		-40°C ≤ T <sub>A</sub> ≤ 125°C			150	
Input Common-mode Voltage	V <sub>CM</sub>	V <sub>+</sub> =30V, CMRR>=50dB	0		(V <sub>+</sub> )-1.5	V
		V <sub>+</sub> =30V, CMRR>=50dB			( V <sub>+</sub> )- 2	
Common-mode Rejection Ratio	CMRR	R <sub>S</sub> ≤10kΩ	65	85		dB
Large Signal Gain	A <sub>VO</sub>	V <sub>+</sub> =15V, R <sub>L</sub> =2kΩ, V <sub>O</sub> =1.4V~11.4V	88	100		dB
		V <sub>+</sub> =15V, R <sub>L</sub> =2kΩ, V <sub>O</sub> =1.4V ~11.4V	83			
		-40°C ≤ T <sub>J</sub> ≤ 125°C				
Output Characteristics						
Output Voltage	V <sub>OH</sub>	V <sub>+</sub> =30V, R <sub>L</sub> =2kΩ, -40°C ≤ T <sub>J</sub> ≤ 125°C	26			V
		V <sub>+</sub> =30V, R <sub>L</sub> =10kΩ -40°C ≤ T <sub>J</sub> ≤ 125°C	27	28		
	V <sub>OL</sub>	V <sub>+</sub> =5V, R <sub>L</sub> =10kΩ -40°C ≤ T <sub>J</sub> ≤ 125°C		5	20	mV
Output Current Source	I <sub>SOURCE</sub>	V <sub>ID</sub> =+1V, V <sub>+</sub> =15V, V <sub>O</sub> =2V	20	30		mA
		V <sub>ID</sub> =+1V, V <sub>+</sub> =15V, V <sub>O</sub> =2V -40°C ≤ T <sub>J</sub> ≤ 125°C	10	20		
Output Current Sink	I <sub>SINK</sub>	V <sub>ID</sub> =-1V, V <sub>+</sub> =15V, V <sub>O</sub> =2V	5	8		mA
		V <sub>ID</sub> =-1V, V <sub>+</sub> =15V, V <sub>O</sub> =2V -40°C ≤ T <sub>J</sub> ≤ 125°C	3	6		
		V <sub>ID</sub> =-1V, V <sub>+</sub> =15V, V <sub>O</sub> =0.2V	12	100		μA
Output Short-circuit Current	I <sub>O</sub>	V <sub>+</sub> =15V		30	85	mA

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Power Dissipation						
Power Supply Rejection Ratio	PSRR	R <sub>S</sub> ≤10kΩ, V <sub>+</sub> ≤5V~30V	65	100		dB
Quiescent Current/Amplifier	I <sub>Q</sub>	V <sub>+</sub> =5V		0.430	1.15	mA
		V <sub>+</sub> =5V, -40°C ≤ T <sub>J</sub> ≤ 125°C		0.7	1.2	
		V <sub>+</sub> =30V		0.660	2.85	
		V <sub>+</sub> =30V, -40°C ≤ T <sub>J</sub> ≤ 125°C		1.5	3	
Dynamic Characteristics						
Gain Bandwidth Product	GBW	T <sub>A</sub> =25°C, V <sub>+</sub> =30V, f=100kHz V <sub>IN</sub> =10mV, R <sub>L</sub> =2kΩ, C <sub>L</sub> =100pF		1		MHz
		T <sub>A</sub> =125°C, V <sub>+</sub> =30V, f=100kHz V <sub>IN</sub> =10mV, R <sub>L</sub> =2kΩ, C <sub>L</sub> =100pF		0.7		
Slew Rate	SR	V <sub>+</sub> =15V, R <sub>L</sub> =2kΩ, V <sub>IN</sub> =0.5V~3V C <sub>L</sub> =100pF, Unit Gain		0.4		V/μs
Phase Margin	Z			60		Degrees
Others						
Voltage Noise Density	e <sub>n</sub>	f=1kHz, R <sub>S</sub> =100Ω, V <sub>+</sub> =30V		60		nV/√Hz
Total Harmonic Distortion	THD	f=1kHz, A <sub>v</sub> =20dB, R <sub>L</sub> =2kΩ V <sub>O</sub> =2VPP, C <sub>L</sub> =100pF, V <sub>+</sub> =30V		0.015		%

# PACKAGE OUTLINE DIMENSIONS

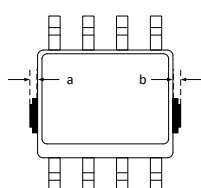
## SOT23-5



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
$\theta$	0°	8°	0°	8°

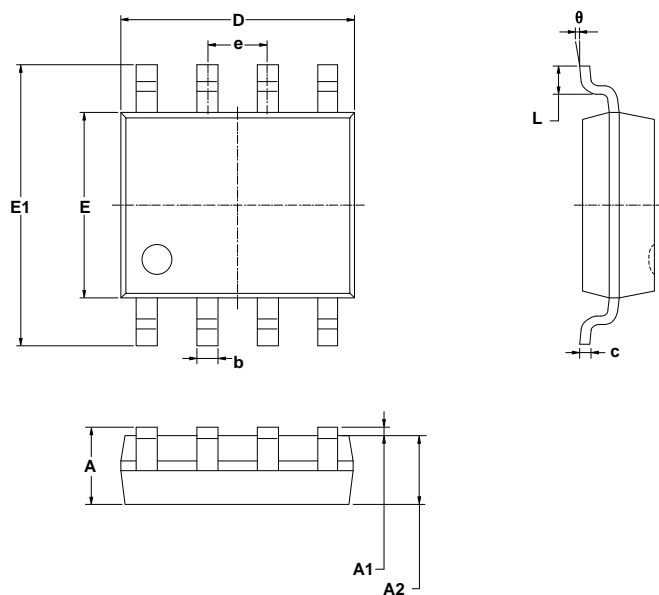
Note: In addition to the package size, a and b are allowed to have the maximum size of 0.15mm for waste glue simultaneously.

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



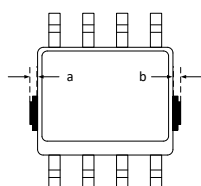


## SOP8

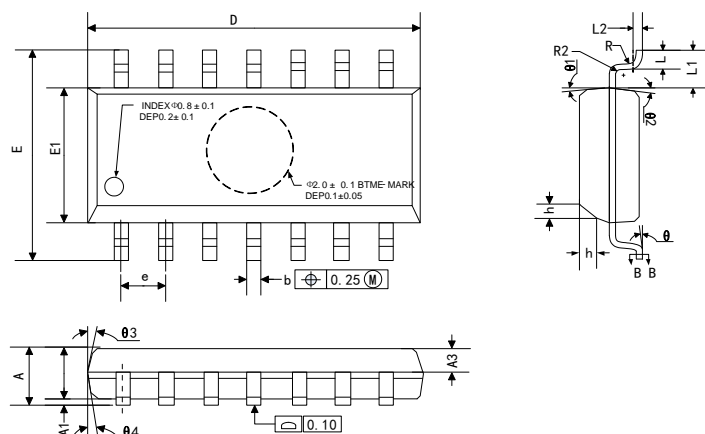


Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0 °	8 °	0 °	8 °

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



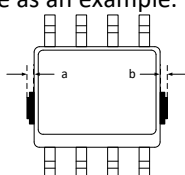
## SOP14



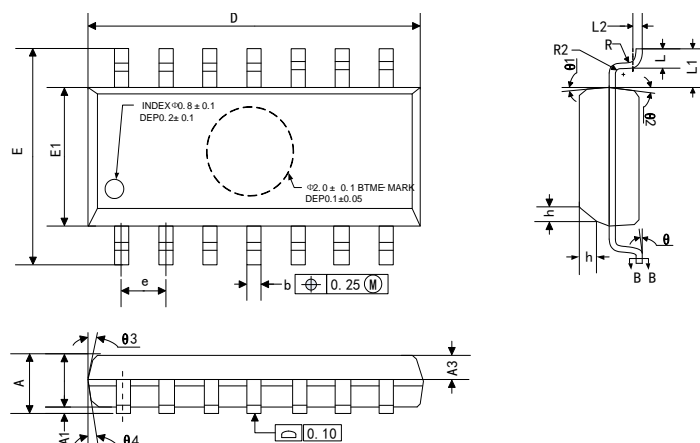
Symbol	Dimensions in Millimeters		
	Min	Typ	Max
A	1.35		1.75
A1	0.10		0.25
A2	1.25		1.65
A3	0.55		0.75
D	8.53		8.73
E	5.80		6.20
E1	3.80		4.00
e	1.27 BSC		
L	0.45		0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07		
R1	0.07		
h	0.30		0.50
θ	0 °		8 °
θ1	6 °	8 °	10 °
θ2	6 °	8 °	10 °
θ3	5 °	7 °	9 °
θ4	5 °	7 °	9 °

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.



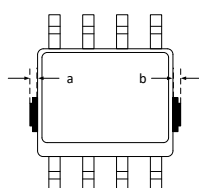
**TSSOP14**



Symbol	Dimensions in Millimeters		
	Min	Typ	Max
A			1.20
A1	0.05		0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20		0.30
b1	0.19	0.22	0.25
c	0.13		0.19
c1	0.12	0.13	0.14
D	4.86	4.96	5.06
E1	4.30	4.40	4.50
E	6.20	6.40	6.60
e	0.65BSC		
L	0.45		0.75
L1	1.00BSC		
θ	0		8°
L/F Carrier Size(mil)	79×79		90×110
	118×153		

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 SPECIFICATIONS

### 1. Marking Drawing Description



Product Name : 321, MS358, MS324, MS324T, MS324N

Product Code: XXXX, XXXXXX

### 2. Marking Drawing Demand

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

### 3. Packaging Specifications

Device	Package	Piece/Tray	Tray/Box	Piece /Box	Box/Carton	Piece/Carton
MS321	SOT23-5	3000	10	30000	4	120000
MS358	SOP8	2500	1	2500	8	20000
MS324	SOP14	2500	1	2500	8	20000
MS324T	TSSOP14	3000	1	3000	8	24000
MS324N	QFN16	4000	1	4000	8	32000

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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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