Precision, Low Noise, CMOS, Rail-to-Rail Input and Output Operational Amplifier

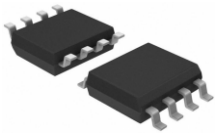
PRODUCT DESCRIPTION

The MS8605 and MS8606 are single channel, dual channel rail-to-rail input and output, single power supply operational amplifiers respectively, which are featured by low offset voltage, low input noise and wide signal bandwidth.

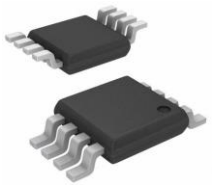
The perfect features make it applicable to filter, integrator, photodiode amplifier. Audio and some AC applications are benefited by wide bandwidth and low distortion features.

The operating temperature range of the MS8605 or MS8606 is -40°C to 125°C.

SOT23-5



SOP8



MSOP8

FEATURES

- Low Offset Voltage : 65μV (Typ), 300μV (Max)
- Low Input Bias Current : 1pA(Max)
- Single Power Supply : 2.7V to 5.5V
- Low Noise : 8nV/√Hz
- High Open-loop Gain : 120dB
- Wide Bandwidth : 10MHz
- Stable Unity Gain

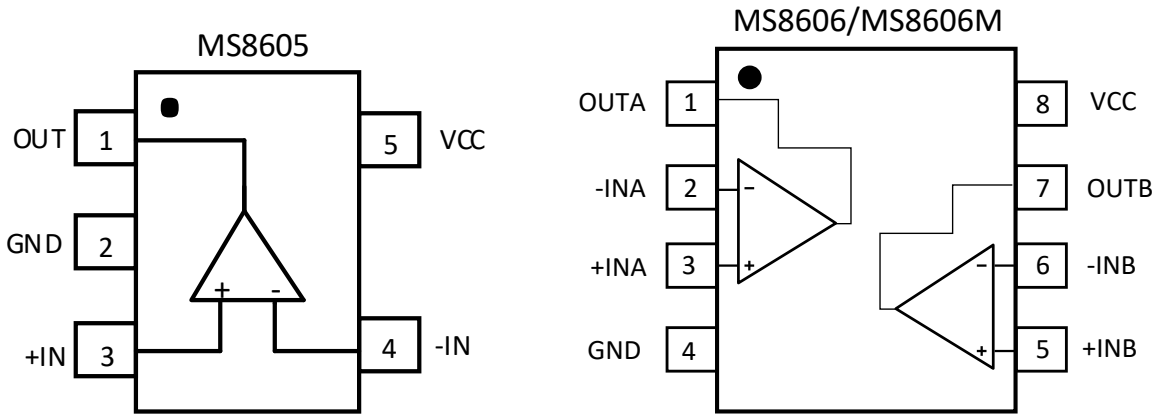
APPLICATIONS

- Photodiode Amplifier
- Multiple-order Filter
- Senor
- Audio
- Bar Code Scanner

PRODUCT SPECIFICATION

Part Number	Package	Marking
MS8605	SOT23-5	8605
MS8606	SOP8	MS8606
MS8606M	MSOP8	MS8606M

PIN CONFIGURATION



PIN DESCRIPTION

Pin	Name	Type	Description
MS8605			
1	OUT	O	Channel Output
2	GND	-	Ground
3	+IN	I	Positive Input
4	-IN	I	Negative Input
5	VCC	-	Power Supply
MS8606/MS8606M			
1	OUTA	O	Channel A Output
2	-INA	I	Negative Input (Channel A)
3	+INA	I	Positive Input (Channel A)
4	GND	-	Ground
5	+INB	I	Positive Input (Channel B)
6	-INB	I	Negative Input (Channel B)
7	OUTB	O	Channel B Output
8	VCC	-	Power Supply

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	Ratings	Unit
Power Supply	VCC	6	V
Input Voltage		0 ~ VCC	V
Differential Input Voltage		±6	V
Junction Temperature		-65 ~ 150	°C
Operating Temperature	T_A	-40 ~ 125	°C
Storage Temperature	Tstg	-65 ~ 150	°C
Lead Temperature		260	°C

ELECTRICAL CHARACTERISTICS (5V)

VCC=5V, V_{CM}=2.5V. Unless otherwise noted, T_A= 25°C ±2°C.

Input Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Offset Voltage	V_{OS}	VCC=5V, V_{CM}=2.5V		65		μV
		VCC=5V, V_{CM}=0V~5V		80	300	
		-40°C≤T_A≤125°C			750	
Input Bias Current	I_B			0.2		pA
Input Offset Current	I_{OS}			0.1		pA
Common-mode Rejection Ratio	CMRR	V_{CM}=0V~5V	85	100		dB
		-40°C≤T_A≤125°C	75	90		
Input Voltage			0		5	V
Large Signal Gain	A_{VO}	R_L= 2kΩ, Vo= 0.5V~4.5V	115	120		dB
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T_A$	-40°C≤T_A≤125°C		1.5	10	μV/°C
Input Capacitance	C_{DIFF}			2.6		pF
	C_{CM}			8.8		pF

Dynamic Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Unit Gain Bandwidth	GBP			10		MHz
Slew Rate	SR	R_L = 2kΩ, C_L=16pF		7		V/μs
Setting Time 0.01%	t_s	0V~2V step, A_V=1		<1		μs
Phase Margin	Φ_O			65		Deg

Output Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Output High Voltage	V_{OH}	IL=1mA	4.96	4.99		V
		IL=10mA	4.7	4.79		
		-40°C≤TA≤125°C	4.7			
Output Low Voltage	V_{OL}	IL=1mA		20	40	mV
		IL=10mA		170	210	
		-40°C≤TA≤125°C			290	
Short-circuit Current	I_{SC}			±80		mA
Closed-loop Output Impedance	Z_{OUT}	f=1MHz, A_V=1		11		Ω
Overload Recovery Time		±2.5V, RL=10k， FIN=-50~50mV, Avo=-100		1.6		μs

Power Supply

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Power Supply Rejection Ratio	PSRR	2.7V<V_{CM} <5.5V	85	95		dB
		-40°C≤TA≤125°C	70	90		dB
Supply Current/Amplifier	I_{SY}	I_{OUT}=0mA		1.5		mA
		-40°C≤TA≤125°C			1.8	

Noise Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
1/f Noise	e_{np-p}	f=0.1Hz~10Hz		2.3	3.5	μV
Voltage Noise Density	e_n	f = 1kHz		8.5		nV/√Hz
		f = 10kHz		4		
Current Noise Density	i_n	f = 1kHz		0.01		fA/√Hz

ELECTRICAL CHARACTERISTICS (2.7V)

VCC=2.7V, V_{CM}=1.35V. Unless otherwise noted, T_A= 25°C ±2°C.。

Input Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Offset Voltage	V_{OS}	VCC=2.7V, V_{CM}=1.35V		65		μV
		VCC=2.7V, V_{CM}=0V~2.7V		80	300	
		-40°C≤T_A≤125°C			750	
Input Bias Current	I_B			0.2		pA
Input Offset Current	I_{OS}			0.1		pA
Common-mode Rejection Ratio	CMRR	V_{CM}=0V~2.7V	115	120		dB
		-40°C≤T_A≤125°C	70	85		
Input Voltage			0		2.7	V
Large Signal Gain	A_{VO}	R_L= 2kΩ, Vo= 0.5V~2.2V	110	118		dB
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T_A$	-40°C≤T_A≤125°C		1.5	10	μV/°C
Input Capacitance	C_{DIFF}			2.6		pF
	C_{CM}			8.8		pF

Dynamic Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Unit Gain Bandwidth	GBP			9.5		MHz
Slew Rate	SR	R_L = 2kΩ, C_L=16pF		7		V/μs
Setting Time 0.01%	t_s	0V~1V step, A_V=1		<0.5		μs
Phase Margin	Φ_O			50		Deg

Output Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Output High Voltage	V_{OH}	IL=1mA	2.6	2.66		V
		-40°C≤T_A≤125°C	2.6			
Output Low Voltage	V_{OL}	IL=1mA		25	40	mV
		-40°C≤T_A≤125°C			50	
Short-circuit Current	I_{SC}			±30		mA
Closed-loop Output Impedance	Z_{OUT}	f=1MHz, A_V=1		1.2		Ω

Power Supply

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Power Supply Rejection Ratio	PSRR	2.7V<V_{CM} <5V	80	95		dB
		-40°C≤T_A≤125°C	70	90		dB
Supply Current/Amplifier	I_{SY}	I_{OUT}=0mA		1.2		mA
		-40°C≤T_A≤125°C			1.5	

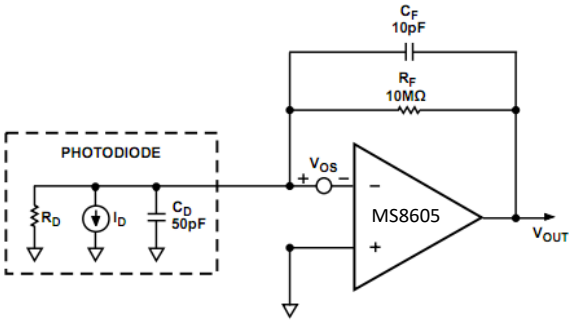
Noise Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
1/f Noise	e_{np-p}	f=0.1Hz~10Hz		2.3	3.5	μV
Voltage Noise Density	e_n	f = 1kHz		8		nV/√Hz
		f = 10kHz		4		
Current Noise Density	i_n	f = 1kHz		0.01		fA/√Hz

TYPICAL APPLICATION

Photodiode Pre-amplifier

The MS860X serial has the advantages of low offset voltage and low input current. It could be applicable to photodiode area. In addition, the low noise feature provides high sensitivity for application lines.



The input bias current of the amplifier would generate a error item, that is proportional to R_F. And the offset voltage would cause dark current due to shunt resistance R_D. The output terminal of the amplifier indicates the error item. The formula of error voltage is as follows:

$$E_O = V_{OS}\left(1+\frac{R_F}{R_D}\right)+R_F I_B$$

R_F/R_D could be ignored.

At indoor temperature, for the MS8605, the input bias current of is 0.2pA. The offset voltage is 20μV. The typical value of R_D is 1GΩ.

The error voltage is about 100μV at indoor temperature. Then it increases to 1mV at 85°C.

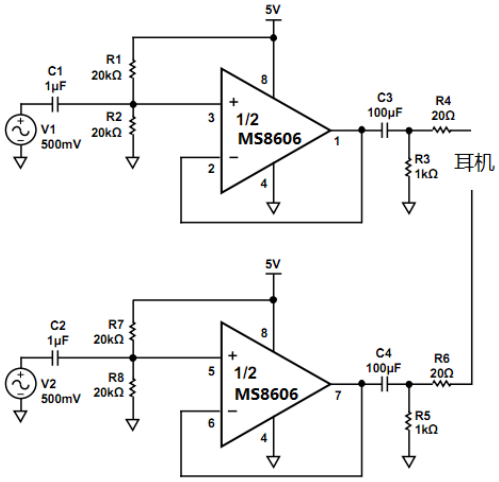
The formula of the maximum realized signal bandwidth is as follows:

$$f_{MAX} = \sqrt{\frac{f_t}{2\pi R_F C_F}}$$

f_t is unity gain infrequency of the amplifier .

Audio and PDA Applications

The MS860X serial is characterized by low distortion and wide dynamic range, which is beneficial to audio and PDA applications, including microphone amplifier and line output buffer.



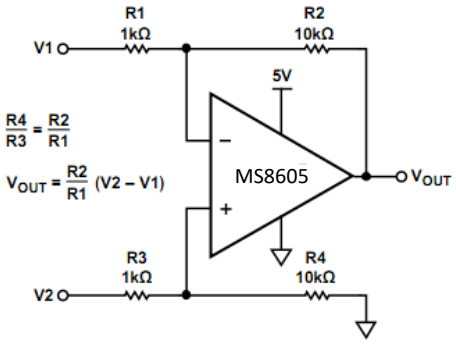
In above diagram, R1 and R2 bias input voltage as half of power supply voltage, thus maximizing signal bandwidth range. C1 and C2 are used to AC couple input signal. C1, R1 and R2 make up a high-pass filter, and the corner frequency is 1/[2π(R1||R2)C1]. The high output of the MS8606 can drive large resistance load.

The circuit can drive 16Ω earphone as shown above. And the THD+N maintains about -60dB among the whole audio range.

Instrument Amplifier

The MS860X serial has low offset voltage and low noise features and suitable for instrument amplifiers.

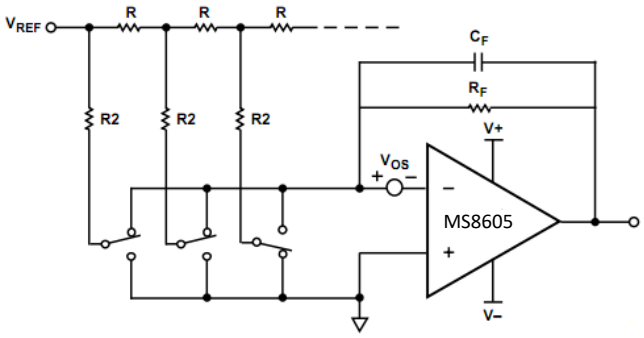
The differential amplifiers are widely applied to high-precision circuits to improve common-mode rejection ratio, which could be up to 85-95dB.



DAC Conversion

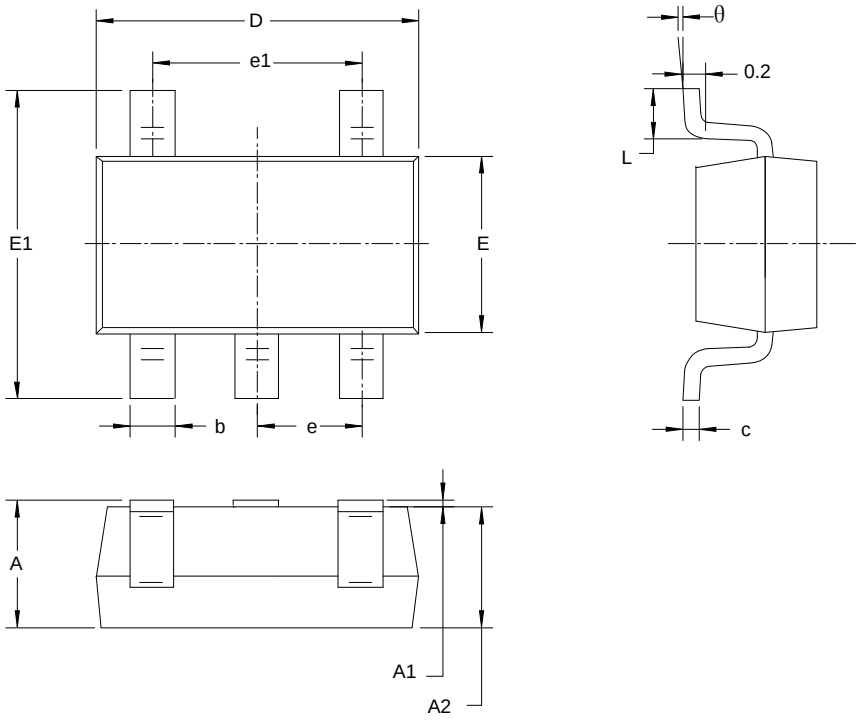
The MS860X serial is featured by low bias current and low offset voltage, and it is the optimal selection for output buffer of current output DAC.

The following diagram is typical structure of the MS8605 applied to the output terminal of 12-bit DAC.



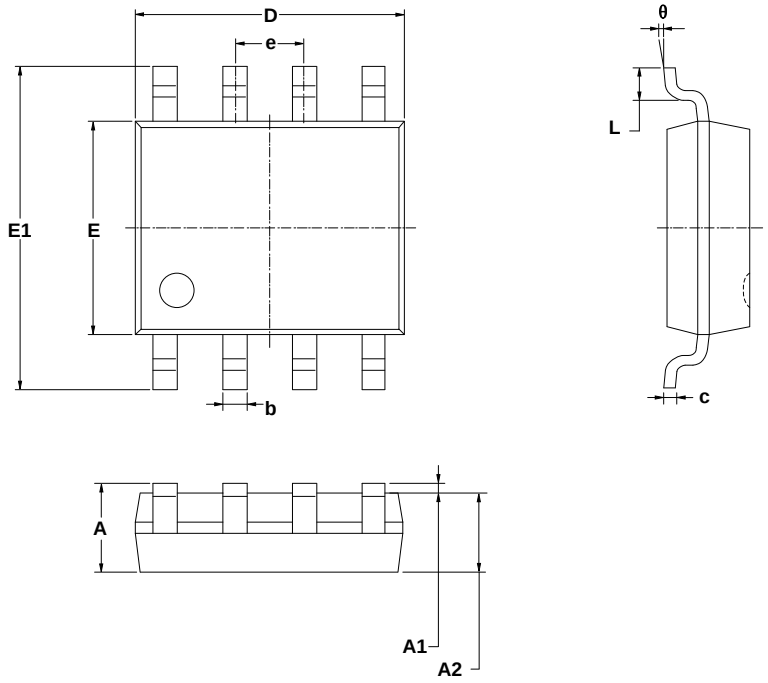
PACKAGE OUTLINE DIMENSIONS

SOT23-5



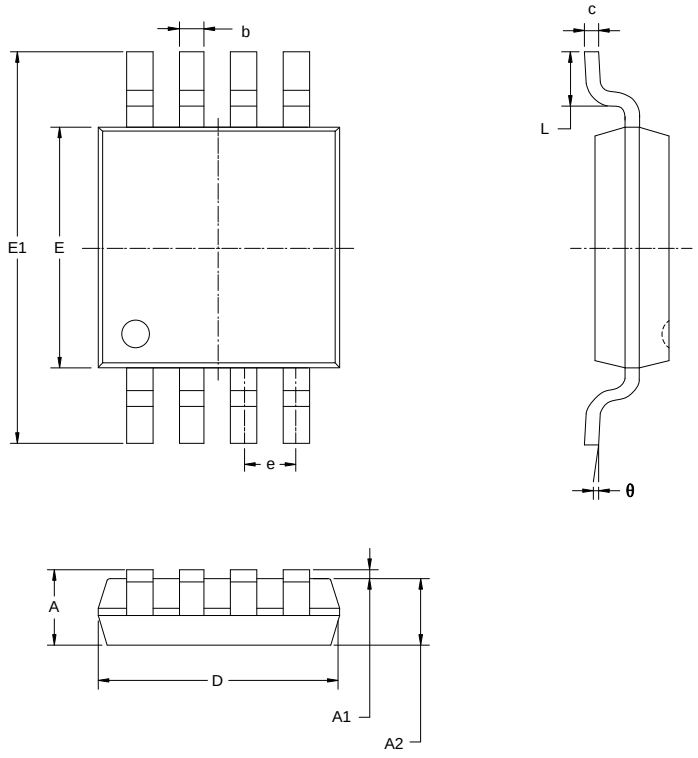
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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

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 º	8 º	0 º	8 º

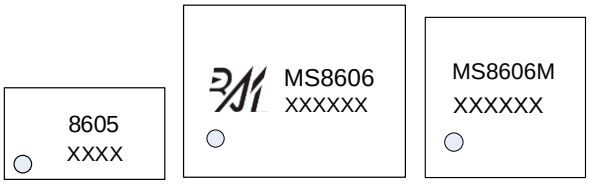
MSOP8



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650BSC		0.026BSC	
L	0.400	0.800	0.016	0.031
θ	0º	6º	0º	6º

MARKING and PACKAGING SPECIFICATIONS

1. Marking Drawing Description



Product Name: 8605, MS8606, MS8606M

Product Code： XXXX, XXXXXX

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
MS8605	SOT23-5	3000	10	30000	4	120000
MS8606	SOP8	2500	1	2500	8	20000
MS8606M	MSOP8	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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