500nA，轨至轨，CMOS 运算放大器

概述

SID105系列产品是专注于超低功耗、轨至轨、CMOS运算放大器，最低工作电压可以支持到1.4V，并且工作时每个通道仅消耗500nA的电流。特别适合穿戴式、独立式等对功耗敏感的电池供电场景。

SID105系列产品拥有15kHz的增益带宽积，外接500pF电容负载时也能保证单位增益下稳定工作，并且内置了EMI滤波器，可以抑制外部干扰，同时拥有较低的失调电压和温漂。低至1pA的输入偏置电流让该系列产品在传感器应用场景更具优势。

SID105系列产品提供单通道、双通道、四通道的多种封装形式，适配于各种应用。

特性

- 超低功耗：500nA/通道
- 宽输入的供电范围：1.4V to 5.5V
- 轨至轨的输入和输出
- 低失调电压：2.5mV (最大)
- 失调电压的温度漂移：1.2μV/℃
- 超低的输入失调电流：1pA
- 增益带宽积：15kHz
- 单位增益稳定
- 内置 EMI 滤波器
- 提供多种封装形式：
  单通道：SOT-353、SOT23-5、X2SON-5
  双通道：DFN2x2-8L、SOP8、MSOP8
  四通道：SOP14、TSSOP14、QFN2x2-16L

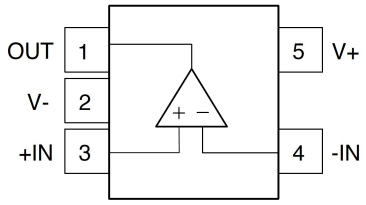
应用产品

- 人体热释电传感设备
- 高侧和低侧的电流采样
- 独立式烟雾报警器
- 运动检测装置
- 可穿戴设备

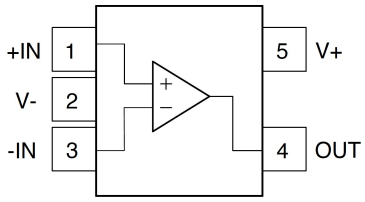
产品信息

产品名称	封装	尺寸
SID105S-X05	X2SON-5	0.80mm*0.80mm
SID105S-D05	DFN1x1-5L	1.00mm*1.00mm
SID105S-A05A/B	SOT353(SC70-5)	1.25mm*1.00mm
SID105S-T05A/B	SOT23-5	2.92mm*1.60mm
SID105D-D08	DFN2x2-8L	2.00mm*2.00mm
SID105D-M08	MSOP8	3.00mm*3.00mm
SID105D-S08	SOP8	4.90mm*3.90mm
SID105Q-Q14	QFN2x2-16L	2.00mm*2.00mm
SID105Q-C14	TSSOP14	4.40mm*5.00mm
SID105Q-S14	SOP14	8.65mm*3.90mm

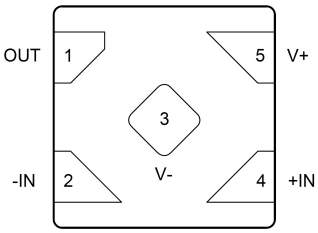
引脚定义



SOT23-5_A/SOT353_A

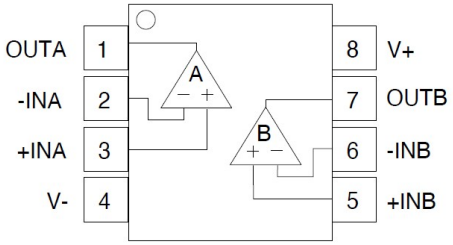


SOT23-5_B/SOT353_B

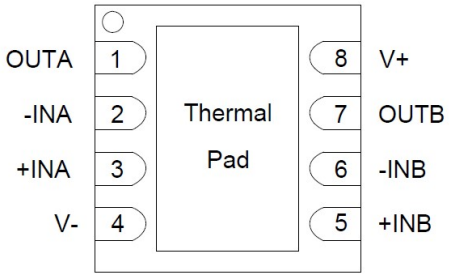


X2SON-5/DFN1x1-5L

引脚 Pin				I/O	描述 Description
名称 Name	SOT23-5_A SOT353_A	SOT23-5_B SOT353_B	X2SON-5 DFN1x1-5L		
-IN	4	3	2	I	反相输入端
+IN	3	1	4	I	同相输入端
OUT	1	4	1	O	输出端
V-	2	2	3	-	负电源
V+	5	5	5	-	正电源



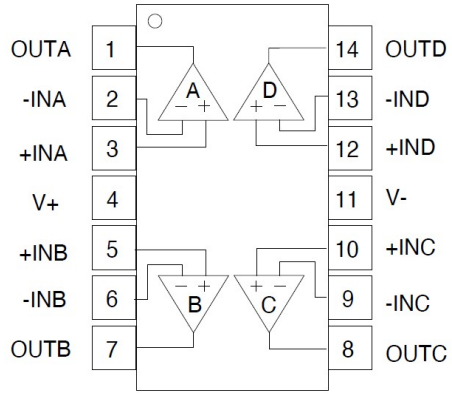
SOP8/MSOP8



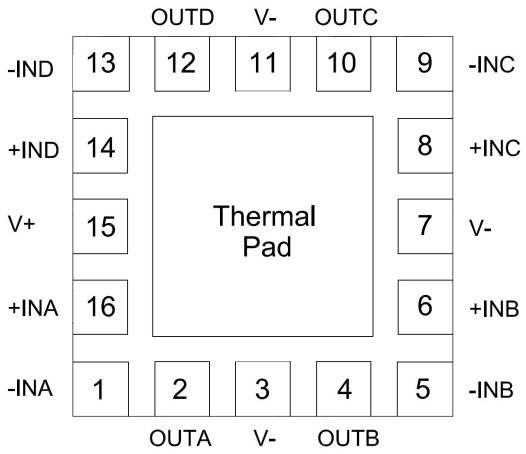
DFN2x2-8L

引脚 Pin			I/O	描述 Description
名称 Name	SOP8、MSOP8	DFN2x2-8L		
-INA	2	2	I	反相输入端，通道 A
+INA	3	3	I	同相输入端，通道 A
-INB	6	6	I	反相输入端，通道 B
+INB	5	5	I	同相输入端，通道 B
OUTA	1	1	O	输出端，通道 A
OUTB	7	7	O	输出端，通道 B
V-	4	4	-	负电源
V+	8	8	-	正电源

引脚定义



SOP14/TSSOP14



QFN2*2-16L

引脚 Pin			I/O	描述 Description
名称 Name	SOP14、TSSOP14	QFN2*2-16L		
-INA	2	1	I	反相输入端，通道 A
+INA	3	16	I	同相输入端，通道 A
-INB	6	5	I	反相输入端，通道 B
+INB	5	6	I	同相输入端，通道 B
-INC	9	9	I	反相输入端，通道 C
+INC	10	8	I	同相输入端，通道 C
-IND	13	13	I	反相输入端，通道 D
+IND	12	14	I	同相输入端，通道 D
OUTA	1	2	O	输出端，通道 A
OUTB	7	4	O	输出端，通道 B
OUTC	8	10	O	输出端，通道 C
OUTD	14	12	O	输出端，通道 D
V-	11	3,7,11	-	负电源
V+	4	15	-	正电源

1 规格参数 Specifications

1.1 极限参数 Absolute Maximum Ratings ①

	最小值	最大值	单位
供电电压 Supply Voltage, V_S = (V+) - (V-)		6	V
共模输入电压 Common Mode Input Voltage ②	(V-) - 0.3	(V+) + 0.3	V
差模输入电压 Differential Input Voltage		|(V+) - (V-)|	V
输入电流 Input Current ②	-10	10	mA
输出短路电流Output Short-Circuit Current ③	See DC Table		
存储温度 Storage Temperature, T_{STG}	-65	150	℃
结温 Junction Temperature		150	℃

① Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

② The input pins are protected by ESD diode clamps which are connected to the power-supply rails. The input current should be limited to 10mA or less if the input voltages extend 0.3V beyond the power-supply rails.

③ Short-Circuit to either power-supply rail.

1.2 静电防护能力 ESD Ratings

			值	单位
$V_{(ESD)}$	静电放电 Electrostatic Discharge	人体模式 Human-Body Model (HBM)	±6000	V
		充电模式 Charged-Device Model (CDM)	±1500	V

1.3 推荐工作条件 Recommended Operating Conditions

		最小值	典型值	最大值	单位
供电电压 Supply Voltage (V+ – V–)		1.4		5.5	V
额定温度 Specified Temperature	V_S = 1.6~5.5V	-40		125	℃
	V_S = 1.4~5.5V	0		125	℃

1.4 直流电气特性 DC Electrical Characteristics

T_A = 25℃, V_S = 1.4V to 5V, V_{CM} = V_{OUT} = V_S/2, 且 R_L = 1MΩ 连接至 V_S/2, 其他情况另做说明。							
参数 Parameter		条 件 Test Conditions	温度 Temp	最小值	典型值	最大值	单位
失调电压 Offset Voltage							
V_{OS}	输入失调电压	V_S = 5V		-2.5	±0.5	2.5	mV
$\Delta V_{OS}/\Delta T$	温漂	V_S = 5V	-40 ℃ to 125℃		±1.2		μV/℃
输入偏置电流 Input Bias Current							
I_B	输入偏置电流				1		pA
I_{OS}	输入失调电流				1		pA
输入阻抗 Input Impedance							
Z_{Diff}	差模				10^{13}||3		Ω||pF
Z_{CM}	共模				10^{13}||6		Ω||pF
输入电压范围 Input Voltage Range							
V_{CM}	共模输入电压范围			-0.2		Vs+0.2	V
CMRR	共模抑制比	V_S = 5V –0.2V < V_{CM} < 4V		74	87		dB
			-40 ℃ to 125℃	70			
		V_S = 5V –0.2V < V_{CM} < 5.2V		63	75		dB
			-40 ℃ to 125℃	60			
输出范围 Output Voltage and Current Range							
V_{OH}	输出电压距离正电源轨	V_S = 5V，R_L = 100kΩ to V_S/2			2.2	6	mV
		V_S = 1.4V, R_L = 100kΩ to V_S/2			2.8	6	
V_{OL}	输出电压距离负电源轨	V_S = 5V，R_L = 100kΩ to V_S/2			2	6	mV
		V_S = 1.4V, R_L = 100kΩ to V_S/2			3.3	6	
I_{SC}	短路电流	V_S = 5V			±18		mA
开环增益 Open-Loop Gain							
A_{OL}	开环增益	V_S = 5V, R_L = 100kΩ, 0.05V < V_{OUT} < 4.95V		109	130		dB
			-40 ℃ to 125℃	104			
		V_S = 5V, R_L = 10kΩ, 0.10V < V_{OUT} < 4.9V		102	123		dB
			-40 ℃ to 125℃	94			
供电范围 Power Supply Range							
I_Q	静态电流	V_S = 5V			500	750	nA
			-40 ℃ to 125℃			1250	
		V_S = 1.4V， V_{CM} = GND			480	730	nA
			0℃ to 125℃			1200	
PSRR	电源抑制比	V_S = 1.6V to 5.5V		74	87		dB

			-40 ℃ to 125℃	72			
		V_S = 1.4V to 5.5V		73	86		dB
			0℃ to 125℃	72			

1.5 交流电气特性 AC Electrical Characteristics

T_A = 25℃, V_S = 1.4V to 5V, V_{CM} = V_{OUT} = V_S/2，且 R_L = 1MΩ 连接至 V_S/2，其他情况另做说明。						
参数 Parameter		条件 Test Conditions	最小值	典型值	最大值	单位
GBP	增益带宽积	V_S = 5V, R_L = 1MΩ, C_L = 20pF		15		kHz
噪声 Noise						
E_n	输入电压噪声	V_S = 5V, f = 0.1Hz to 10Hz		12		μV_{P-P}
e_n	输入电压噪声密度	V_S = 5V, f = 1kHz		280		$nV/\sqrt{Hz}$

1.6 动态电气特性 Dynamic Electrical Characteristics

T_A = 25℃, V_S = 1.4V to 5V, V_{CM} = V_{OUT} = V_S/2，且 R_L = 1MΩ 连接至 V_S/2，其他情况另做说明。						
参数 Parameter		条件 Test Conditions	最小值	典型值	最大值	单位
SR	压摆率 (10% to 90%)	V_S = 5V, G = 1, C_L = 20pF, 1V step		6		V/ms
t_S	建立时间	V_S = 5V, G = 1, C_L = 50pF, 1V step, 0.1%		0.23		ms
t_{OLRT}	过载恢复时间	V_S = 5 V, V_{IN} × gain > V_S		0.20		ms

1.7 直流特征曲线 Typical DC Characteristics

T_A = 25℃, V_S = 5V, V_{CM} = V_{OUT} = V_S/2, 且 R_L = 1MΩ 连接至 V_S/2, 其他情况另做说明。

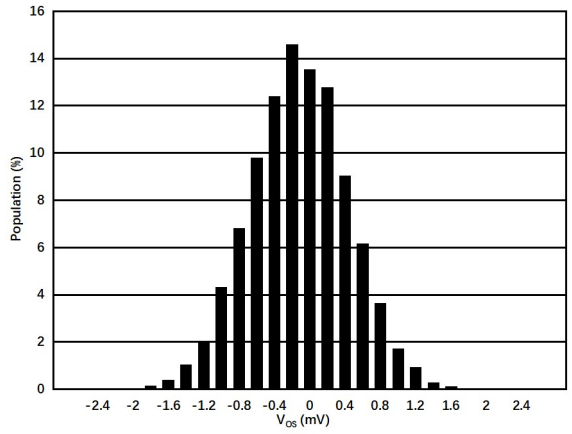


图 1.7.1. 输入失调电压分布图

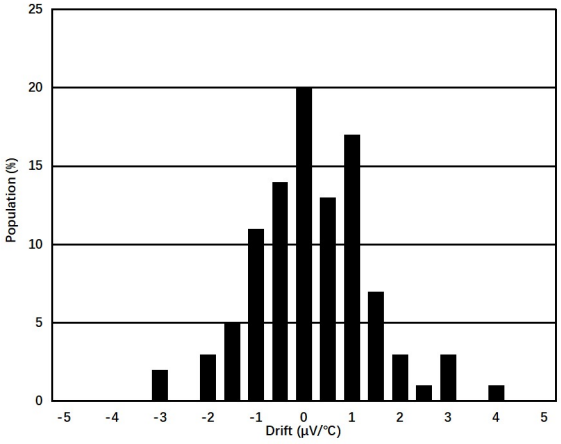


图 1.7.2. 温漂分布图

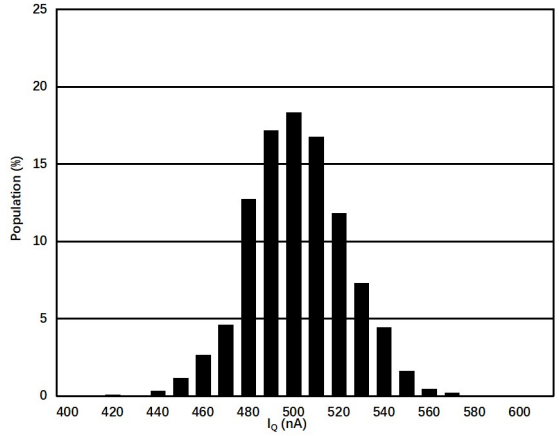


图 1.7.3. 静态电流分布图

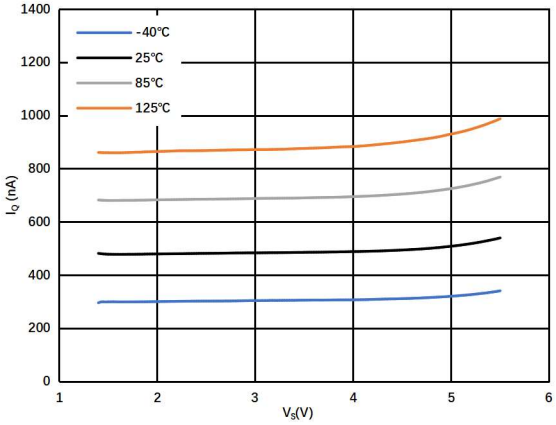


图 1.7.4. 静态电流 vs 供电电压 @ V_{CM} = 0V

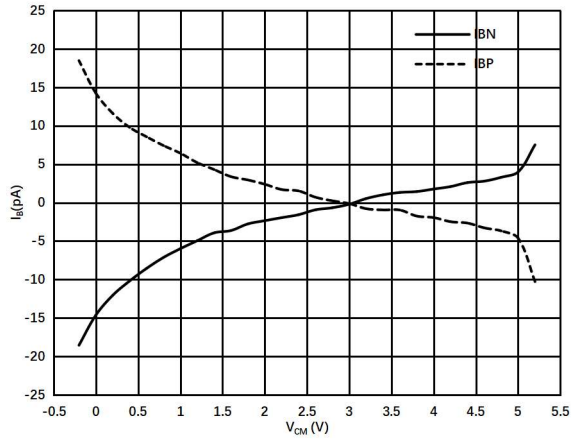


图 1.7.5. 输入偏置电流 vs 共模电压 @ V_S = 5V

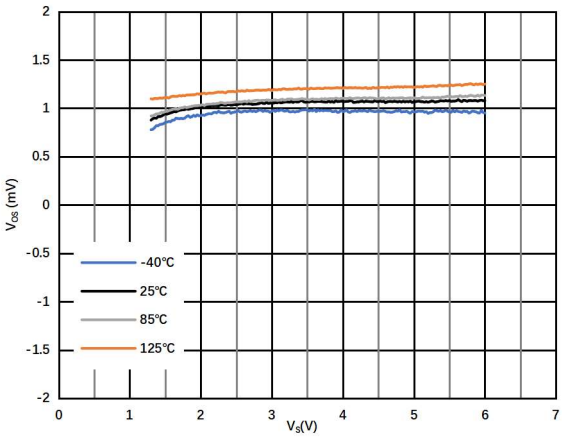


图 1.7.6. 输入失调电压 vs 供电电压 @ V_{CM} = 0V

1.7 直流特征曲线 Typical DC Characteristics (continued)

T_A = 25℃, V_S = 5V, V_{CM} = V_{OUT} = V_S/2, 且 R_L = 1MΩ 连接至 V_S/2, 其他情况另做说明。

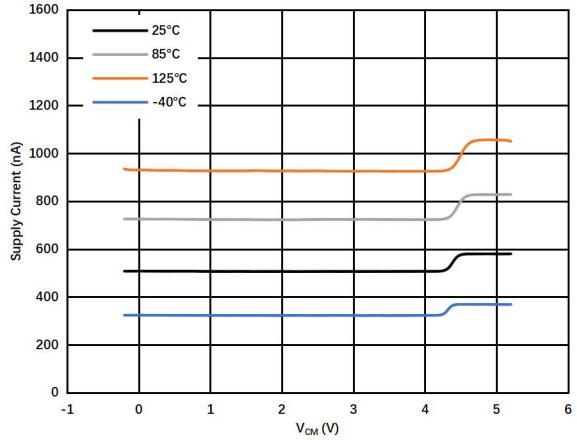


图 1.7.7. 静态电流 vs 共模电压 @ V_s = 5V

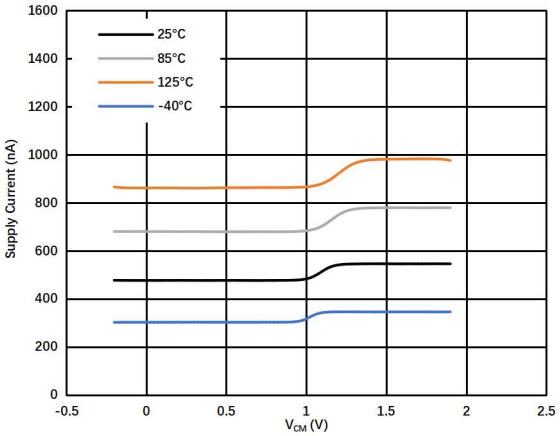


图 1.7.8. 静态电流 vs 共模电压 @ V_s = 1.6V

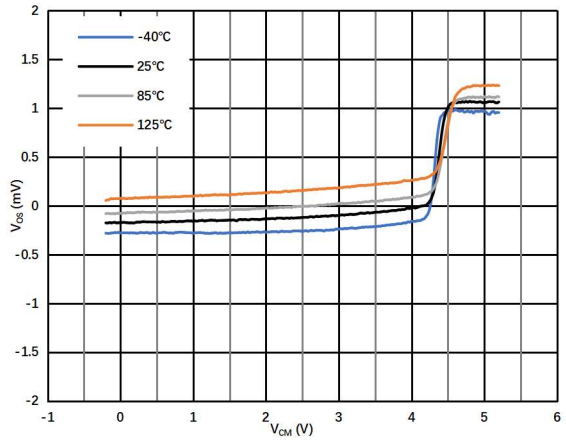


图 1.7.9. 输入失调电压 vs 共模电压 @ V_s = 5V

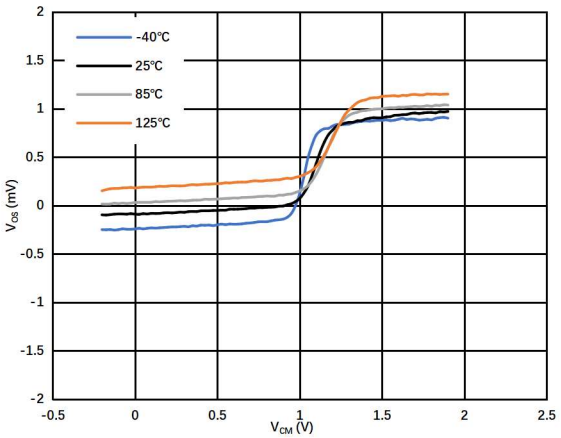


图 1.7.10. 输入失调电压 vs 共模电压@ V_s = 1.6V

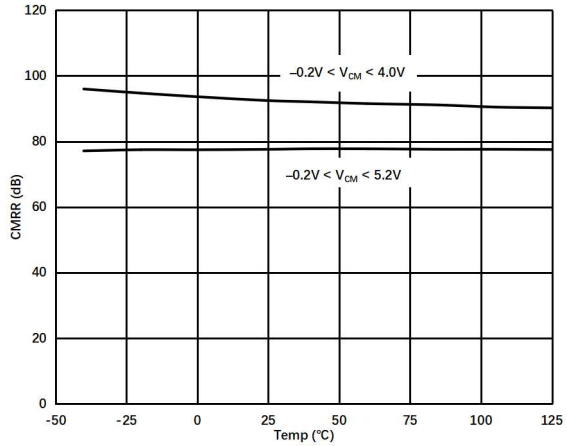


图 1.7.11. 直流 CMRR 与温度的关系 @ V_s = 5V

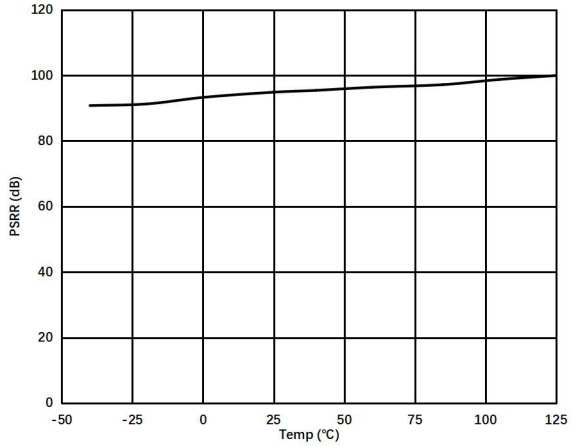


图 1.7.12. 直流 PSRR 与温度的关系 @ V_s = 1.6V 到 5.5V

1.7 直流特征曲线 Typical DC Characteristics (continued)

T_A = 25℃, V_S = 5V, V_{CM} = V_{OUT} = V_S/2, 且 R_L = 1MΩ 连接至 V_S/2, 其他情况另做说明。

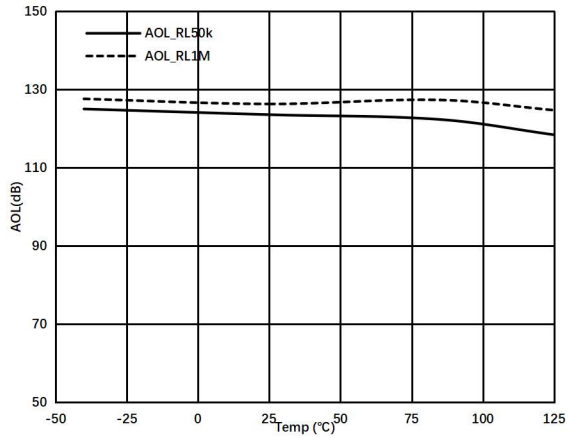


图 1.7.13. 开环增益与温度的关系 @ V_s= 5.0V

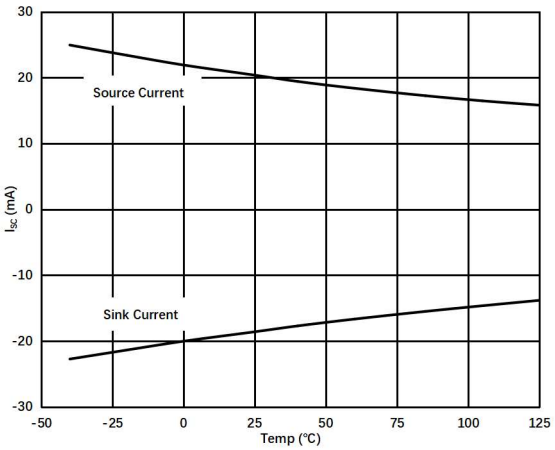


图 1.7.14. 输出短路电流与温度的关系@ V_s = 5V

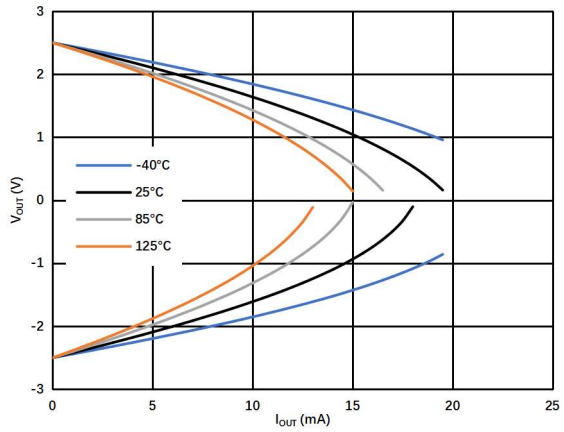


图 1.7.15. 输出电压 vs 输出电流 @ V_s = 5V

1.8 交流特征曲线 Typical AC Characteristics

T_A = 25℃, V_S = 5V, V_{CM} = V_{OUT} = V_S/2, 且 R_L = 1MΩ 连接至 V_S/2, 其他情况另做说明。

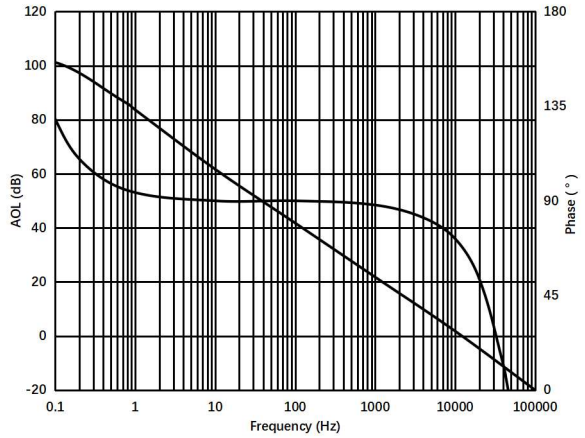


图 1.8.1. 开环增益与相位

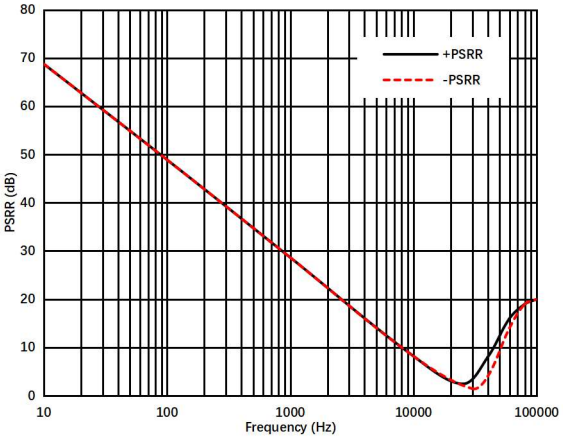


图 1.8.2. PSRR vs 频率

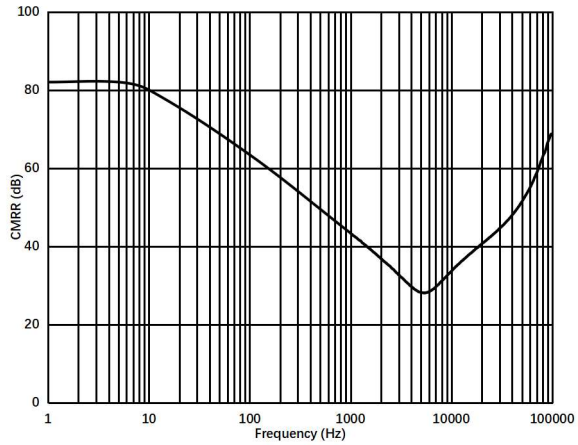


图 1.8.3. CMRR vs 频率

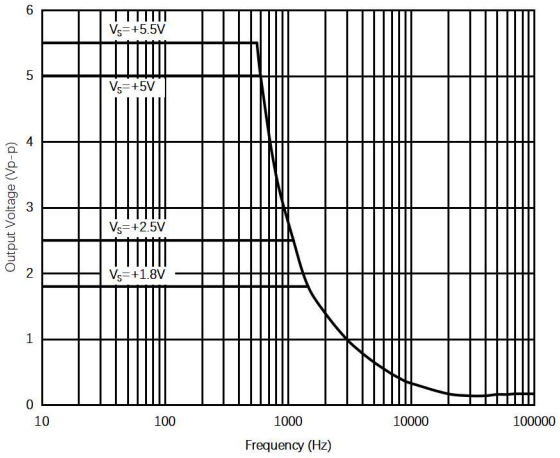


图 1.8.4. 最大输出电压 vs 频率

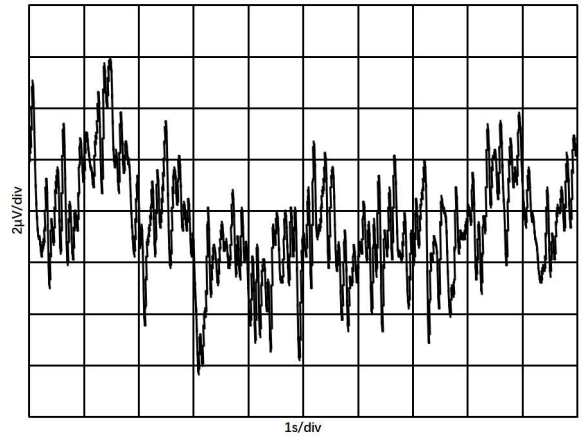


图 1.8.5. 0.1Hz 到 10Hz 噪声

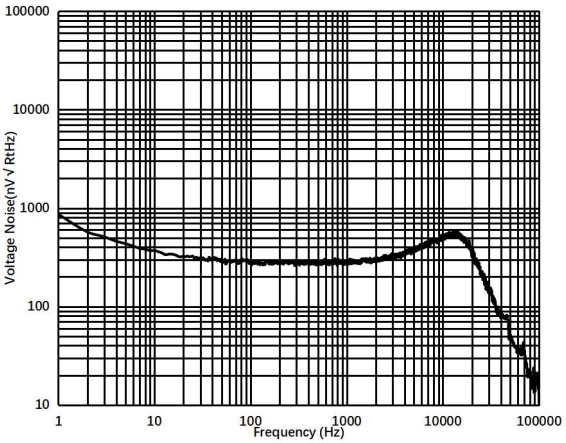


图 1.8.6. 输入噪声密度 vs 频率

1.9 动态特征曲线 Typical Dynamic Characteristics

T_A = 25℃, V_S = 5V, V_{CM} = V_{OUT} = V_S/2, 且 R_L = 1MΩ 连接至 V_S/2, 其他情况另做说明。

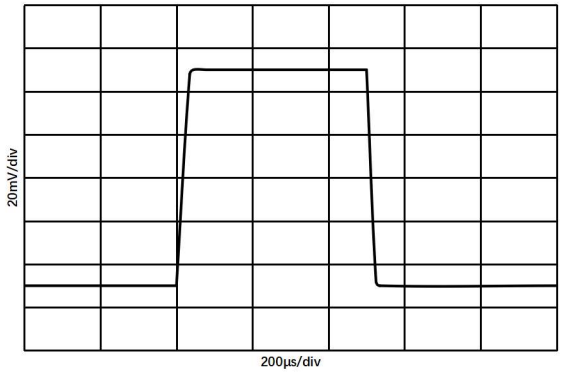


图 1.9.1. 小信号阶跃响应 @ V_s = 5V

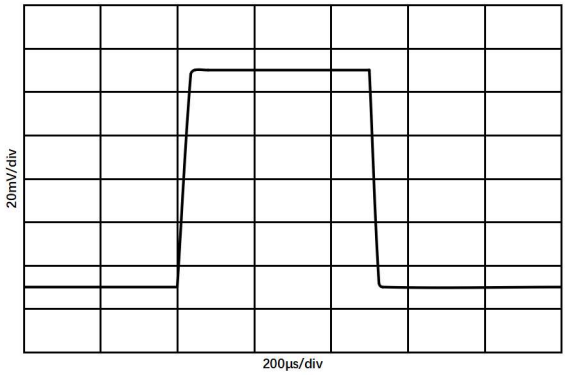


图 1.9.2. 小信号阶跃响应 @ V_s = 1.4V

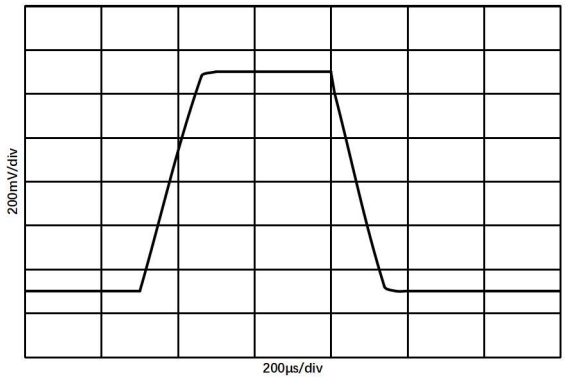


图 1.9.3. 大信号阶跃响应 @ V_s = 5V

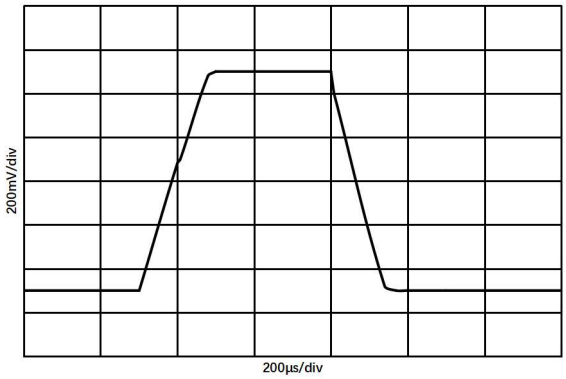


图 1.9.4. 大信号阶跃响应 @ V_s = 1.4V

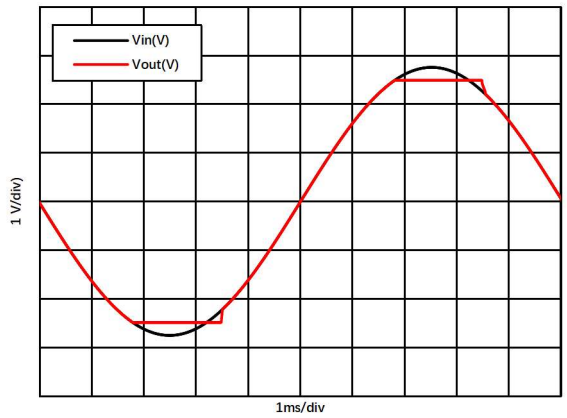


图 1.9.5. 无相位翻转

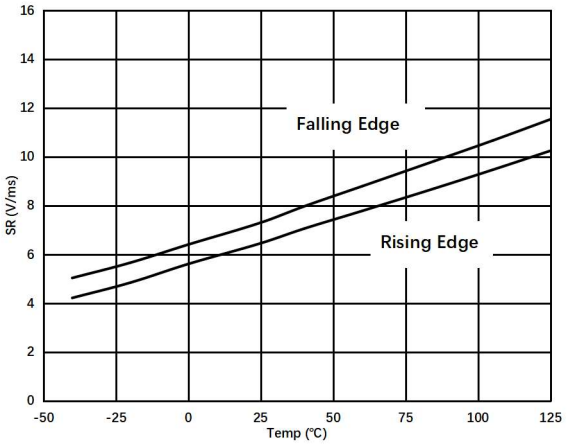


图 1.9.6. 压摆率 vs 温度

1.9 动态特征曲线 Typical Dynamic Characteristics (continue)

T_A = 25℃, V_S = 5V, V_{CM} = V_{OUT} = V_S/2, 且 R_L = 1MΩ 连接至 V_S/2, 其他情况另做说明。

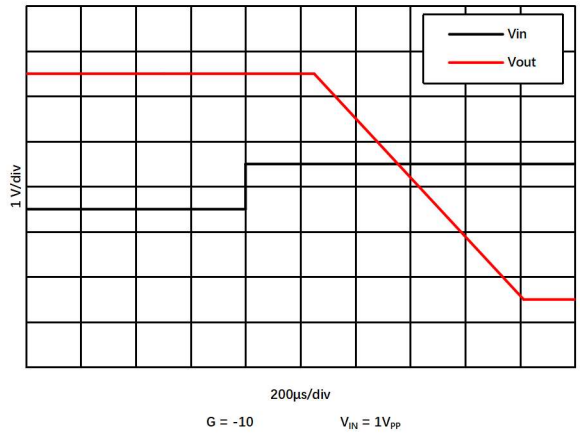


图 1.9.7. 正过载恢复

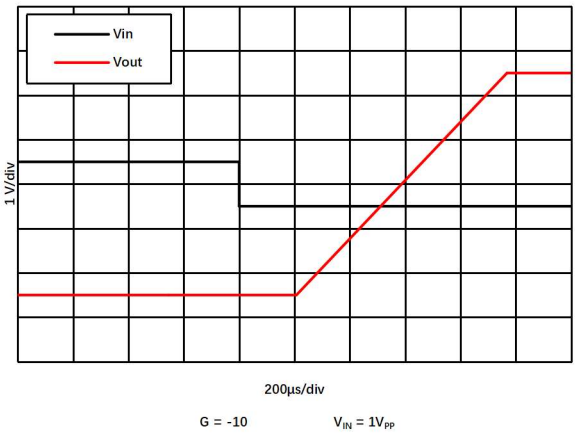


图 1.9.8. 负过载恢复

1.10 通道隔离典型曲线 Typical Channel Separation Characteristics

T_A = 25℃, V_S = 5V, V_{CM} = V_{OUT} = V_S/2, 且 R_L = 1MΩ 连接至 V_S/2, 其他情况另做说明。

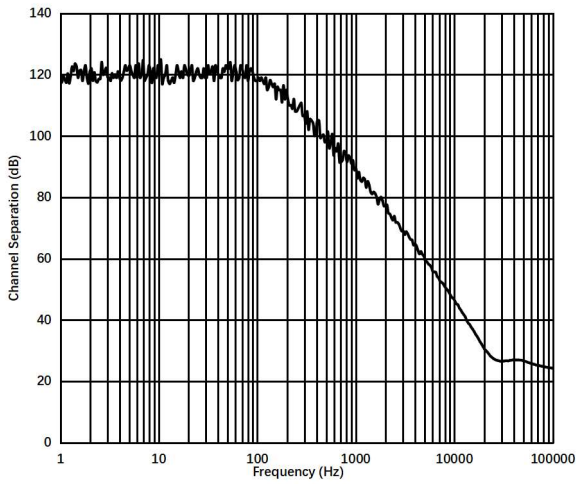
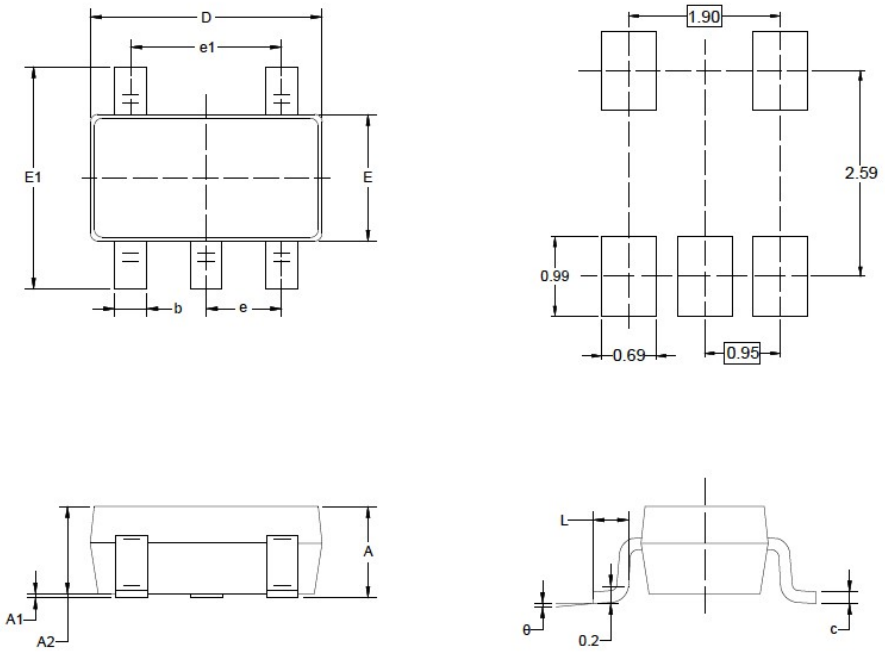


图 1.10.1. 通道隔离度

2 封装外形尺寸 Package Outline Dimensions

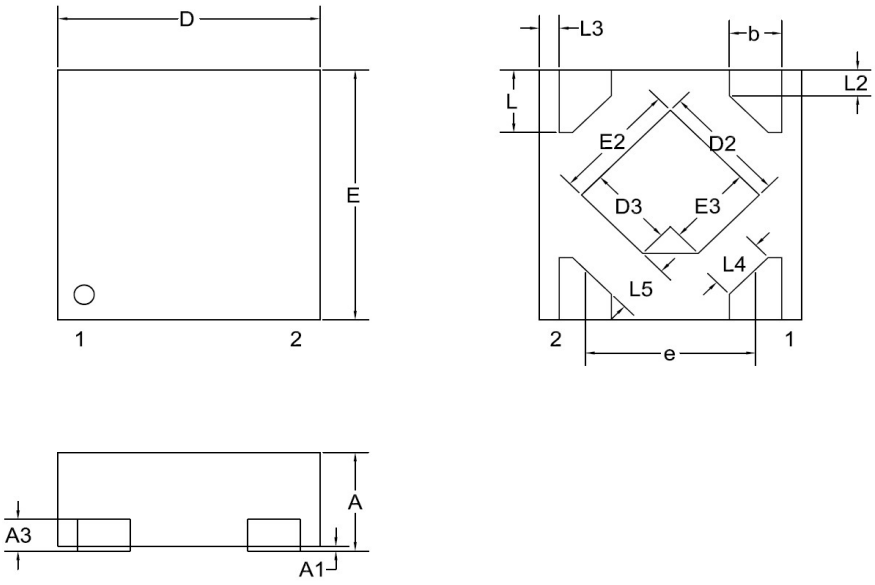
SOT23-5



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	0°	8°	0°	8°

2 封装外形尺寸 Package Outline Dimensions (continued)

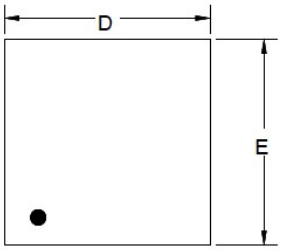
DFN1x1-5L



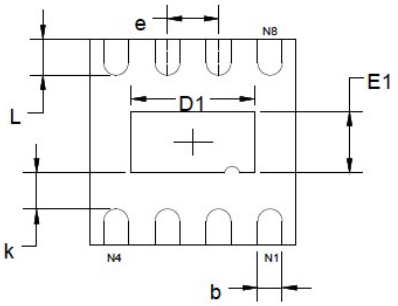
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.350	0.400	0.014	0.016
A1	0.000	0.050	0.000	0.002
b	0.150	0.250	0.006	0.010
A3	0.127REF		0.005 REF	
D	0.950	1.050	0.037	0.041
D2	0.380	0.580	0.015	0.023
D3	0.230	0.430	0.009	0.017
e	0.65BSC		0.026 BSC	
E	0.950	1.050	0.037	0.041
E2	0.380	0.580	0.015	0.023
E3	0.230	0.430	0.009	0.017
L	0.200	0.300	0.008	0.012
L2	0.103REF		0.004 REF	
L3	0.075REF		0.003 REF	
L4	0.208REF		0.008 REF	
L5	0.200REF		0.008 REF	

2 封装外形尺寸 Package Outline Dimensions (continued)

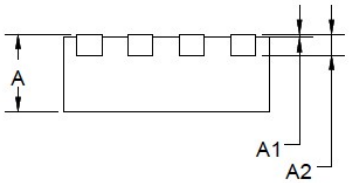
DFN-2×2-8L



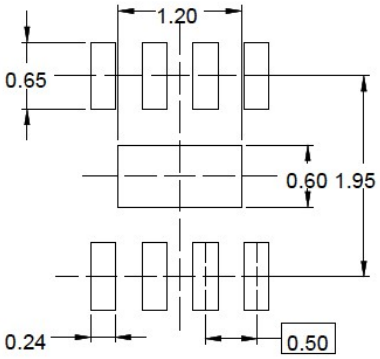
TOP VIEW



BOTTOM VIEW



SIDE VIEW

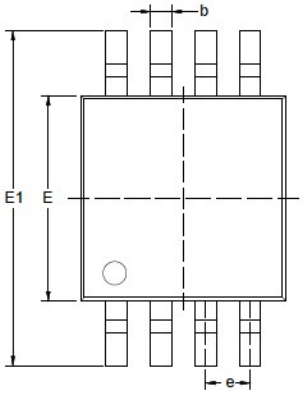


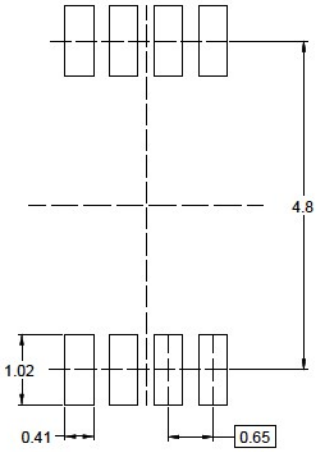
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203 REF		0.008 REF	
D	1.900	2.100	0.075	0.083
D1	1.100	1.300	0.043	0.051
E	1.900	2.100	0.075	0.083
E1	0.500	0.700	0.020	0.028
k	0.200 MIN		0.008 MIN	
b	0.180	0.300	0.007	0.012
e	0.500 TYP		0.020 TYP	
L	0.250	0.450	0.010	0.018

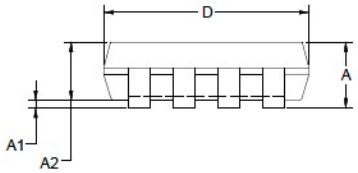
2 封装外形尺寸 Package Outline Dimensions (continued)

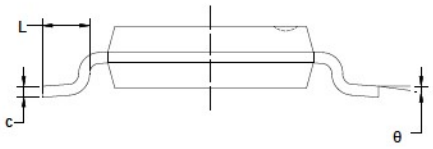
MSOP8





RECOMMENDED LAND PATTERN (Unit: mm)

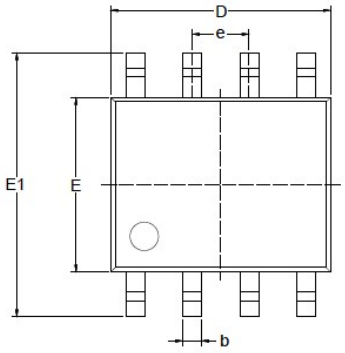


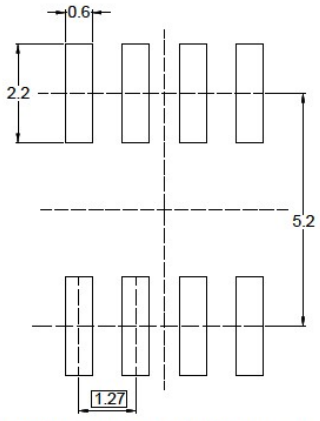


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026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

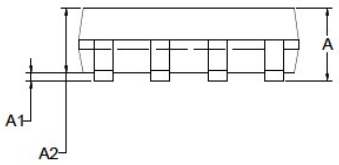
2 封装外形尺寸 Package Outline Dimensions (continued)

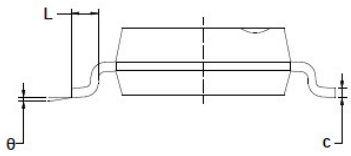
SOP8





RECOMMENDED LAND PATTERN (Unit: mm)

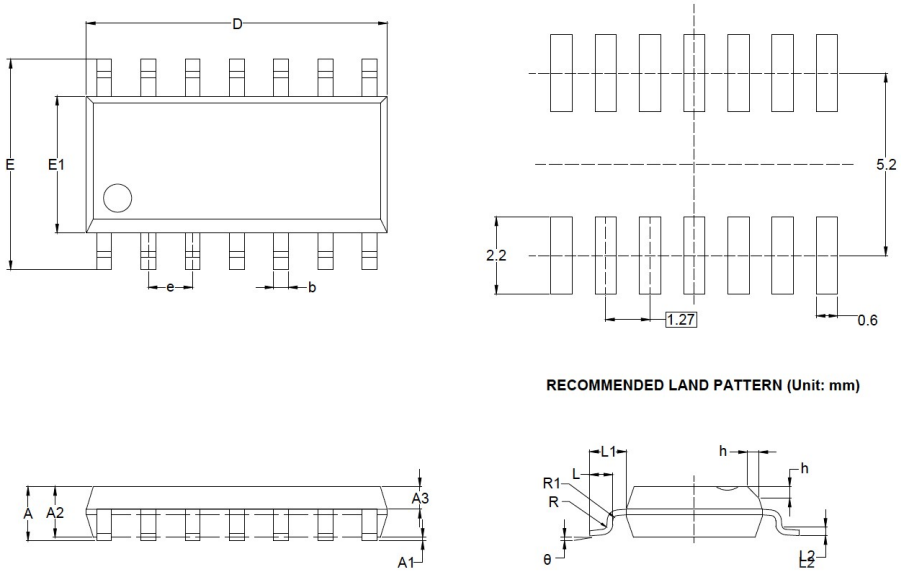




Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

2 封装外形尺寸 Package Outline Dimensions (continued)

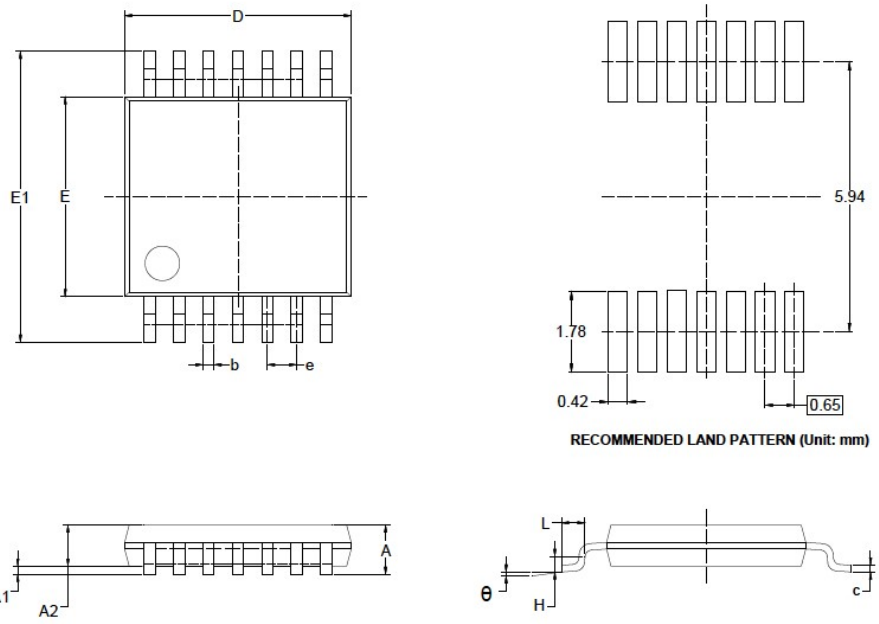
SOP14



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.65	0.049	0.065
A3	0.55	0.75	0.022	0.030
b	0.36	0.49	0.014	0.019
D	8.53	8.73	0.336	0.344
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
L	0.45	0.80	0.018	0.032
L1	1.04 REF		0.040 REF	
L2	0.25 BSC		0.01 BSC	
R	0.07		0.003	
R1	0.07		0.003	
h	0.30	0.50	0.012	0.020
θ	0°	8°	0°	8°

2 封装外形尺寸 Package Outline Dimensions (continued)

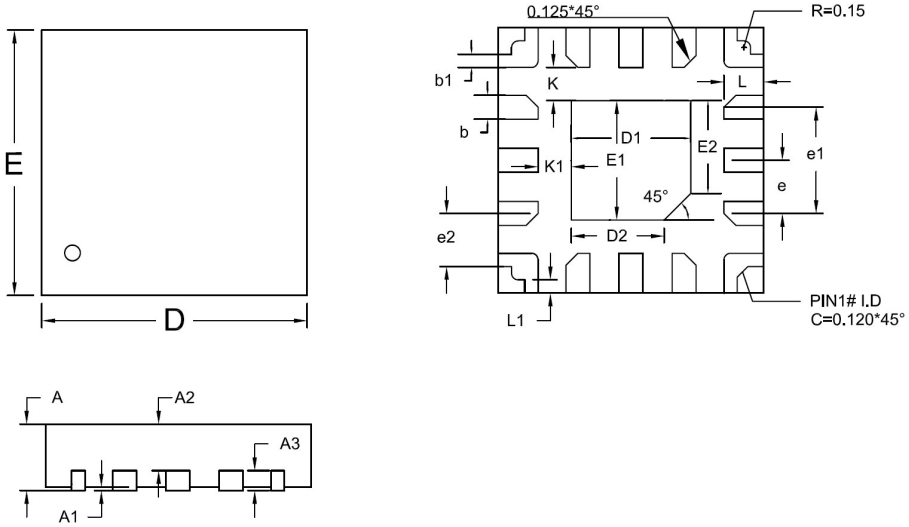
TSSOP14



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	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.02	0.028
H	0.25 TYP		0.01 TYP	
θ	1°	7°	1°	7°

2 封装外形尺寸 Package Outline Dimensions (continued)

QFN2x2-16L

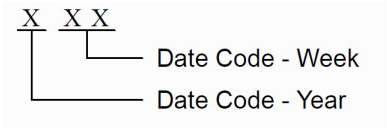


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.50	0.60	0.020	0.024
A1	0.000	0.05	0.000	0.002
A2	0.4TYP		0.016 TYP	
A3	0.152TYP		0.006 TYP	
D	1.95	2.05	0.077	0.081
D1	0.85	0.95	0.033	0.037
D2	0.70TYP		0.028 TYP	
E	1.95	2.05	0.077	0.081
E1	0.85	0.95	0.033	0.037
E2	0.70TYP		0.028 TYP	
e	0.40BSC		0.016 BSC	
e1	0.80BSC		0.031 BSC	
e2	0.40BSC		0.016 BSC	
L	0.25	0.35	0.010	0.014
L1	0.10TYP		0.004 TYP	
b	0.13	0.23	0.005	0.009
b1	0.10TYP		0.004 TYP	
k	0.25BSC		0.010 BSC	
k1	0.25BSC		0.010 BSC	

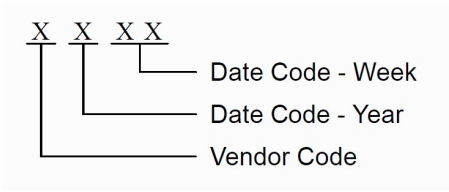
3 包装信息

产品名称	封装	尺寸	丝印	包装数量
SID105S-X05	X2SON-5	0.80mm*0.80mm	XXX	Tape and Reel，10000
SID105S-D05	DFN1x1-5L	1.00mm*1.00mm	XXX	Tape and Reel，10000
SID105S-A05A/B	SOT353(SC70-5)	1.25mm*1.00mm	XXX	Tape and Reel，3000
SID105S-T05A/B	SOT23-5	2.92mm*1.60mm	XXXX	Tape and Reel，3000
SID105D-D08	DFN2x2-8L	2.00mm*2.00mm	05D XXX	Tape and Reel，3000
SID105D-M08	MSOP8	3.00mm*3.00mm	SID105D XXXXXXXX	Tape and Reel，4000
SID105D-S08	SOP8	4.90mm*3.90mm	SID105D XXXXXXXX	Tape and Reel，4000
SID105Q-Q14	QFN2x2-16L	2.00mm*2.00mm	05Q XXX	Tape and Reel，3000
SID105Q-C14	TSSOP14	4.40mm*5.00mm	SID105D XXXXXXXX	Tape and Reel，3000
SID105Q-S14	SOP14	8.65mm*3.90mm	SID105D XXXXXXXX	Tape and Reel，3000

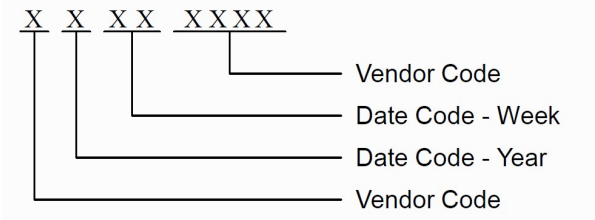
X2SON-5/DFN1x1-5L/SOT353/SC70-5/DFN2x2-8L/QFN2x2-16L



SOT23-5



MSOP8/SOP8/TSSOP14/SOP14



4 版本历史 Revision History

日期 Date	版本 Revision	更新说明 Notes
2023/09	REV.1.0A	初始版本 Predefine
2023/11	REV.1.1A	增加了典型特征曲线 Added Typical Characteristic Curves
2023/12	REV.1.2A	增加了典型特征曲线 Added Typical Characteristic Curves
2024/03	REV.1.3A	增加封装形式 Added Package-QFN2*2-16L
2024/05	REV.1.4A	更新了典型特征曲线 Updated Typical Characteristic Curves
2024/07	REV.1.5A	增加封装形式 Added Package-DFN1*1-5L
2024/08	REV.1.5B	更新封装信息 Updated Package Information
2025/03	REV.1.5C	更新了典型特征曲线 Updated Typical Characteristic Curves