

行业标准双路运算放大器

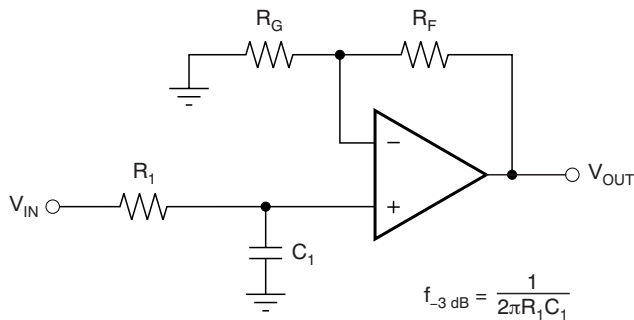
1 特性

- 3V 至 36V 宽电源范围 (B 版本)
- 静态电流: 每个放大器 300μA (B 版本, 典型值)
- 单位增益带宽为 1.2MHz (B 版本)
- 共模输入电压范围包括接地, 支持近地直接检测
- 3mV (25°C 时) 的低输入失调电压 (A 和 B 版本, 最大值)
- 内部射频和 EMI 滤波器 (B 版本)
- 对于符合 MIL-PRF-38535 标准的产品, 所有参数均经过测试, 除非另外注明。对于所有其他产品, 生产流程不一定包含对所有参数的测试。

2 应用

- 商用网络和服务电源单元
- 多功能打印机
- 电源和移动充电器
- 电机控制: 交流感应、刷式直流、无刷直流、高电压、低电压、永久磁性和步进电机
- 台式计算机和主板
- 室内外空调
- 洗衣机、烘干机和冰箱
- 交流逆变器、串式逆变器、中央逆变器和变频器
- 不间断电源
- 可编程逻辑控制器
- 电子销售点系统

单极低通滤波器



$$\frac{V_{\text{OUT}}}{V_{\text{IN}}} = \left(1 + \frac{R_F}{R_G}\right) \left(\frac{1}{1 + sR_1 C_1}\right)$$

3 说明

LM358B 和 LM2904B 是业界通用运算放大器 LM358 和 LM2904 的下一代版本, 其中包括两个高压 (36V) 运算放大器。这些器件为成本敏感型应用带来了出色的价值, 该器件的特性包括低失调电压 (300μV, 典型值)、接地共模输入范围以及高差分输入电压能力。

LM358B 和 LM2904B 运算放大器具有增强的功能, 例如单位增益稳定性、较低的 3mV (室温下的最大值) 失调电压和每个放大器 300μA (典型值) 的静态电流, 从而简化了电路设计。高 ESD (2kV, HBM) 和集成 EMI 以及射频滤波器可支持将 LM358B 和 LM2904B 器件用于最严苛、最具环境挑战性的应用。

LM358B 和 LM2904B 放大器采用行业通用封装 (包括 SOIC、TSSOP 和 VSSOP)。

器件信息⁽¹⁾

器件型号	封装	封装尺寸 (标称值)
LM358B、LM2904B、LM358、LM358A、LM2904、LM2904V、LM258、LM258A	SOIC (8)	4.90mm × 3.90mm
LM358B ⁽²⁾ 、LM2904B ⁽²⁾ 、LM358、LM358A、LM2904、LM2490V	TSSOP (8)	3.00mm × 4.40mm
LM358B ⁽²⁾ 、LM2904B ⁽²⁾ 、LM358、LM358A、LM2904、LM2904V、LM258、LM258A	VSSOP (8)	3.00mm × 3.00mm
LM358、LM2904	SO (8)	5.20mm × 5.30mm
LM358、LM2904、LM358A、LM258、LM258A	PDIP (8)	9.81mm × 6.35mm
LM158、LM158A	CDIP (8)	9.60mm × 6.67mm
LM158、LM158A	LCCC (20)	8.89mm × 8.89mm

(1) 如需了解所有可用封装, 请参阅数据表末尾的可订购产品附录。

(2) 封装仅供预览。

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4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

Changes from Revision V (September 2018) to Revision W	Page
Added specification in the <i>Device Comparison Table</i>	4
Changed CDM ESD rating for LM358B and LM2904B in <i>ESD Ratings</i>	6
Changed V_S to V_+ in <i>Recommended Operating Conditions</i>	7
Changed <i>Thermal Information</i> for the LM158FK and LM158JG devices	7
已添加 <i>Typical Characteristics</i> section for the LM358B and LM2490B op amps	14
已添加 test circuit for THD+N and small-signal step response, $G = -1$ in the <i>Parameter Measurement Information</i> section	23
已更改 the Functional Block Diagram	24
已删除 在 相关链接 部分中删除了 LM358B 和 LM2904B 的预览标识符	29

Changes from Revision U (January 2017) to Revision V	Page
更改了数据表标题	1
更改了特性 部分的前四个项目	1
更改了应用 部分中的第一项并添加了四个新项	1
在说明 部分的第一段中更改了电压值	1
更改了说明 部分第二段中的文本	1
已添加 在数据表中添加了器件 LM358B 和 LM2904B	1
更改了器件信息 表的前三行，并为预览状态器件添加了交叉引用的注释	1
Added <i>Device Comparison table</i>	4
Added a table note to the <i>Pin Functions</i> table	5
Changed "free-air temperature" to "ambient temperature" in the <i>Absolute Maximum Ratings</i> condition statement	6
Changed all entries in the <i>Absolute Maximum Ratings</i> table except T_J and T_{stg}	6

• Deleted lead temperature and case temperature from <i>Absolute Maximum Ratings</i>	6
• Changed device listings and their voltage values in the <i>ESD Ratings</i> table	6
• Changed "free-air temperature" to "ambient temperature" in the <i>Recommended Operating Conditions</i> condition statement	7
• Changed table entries for all parameters in the <i>Recommended Operating Conditions</i> table	7
• Added rows to the Thermal Information table, and a table note regarding device-package combinations	7
• Deleted the <i>Operating Conditions</i> table.....	13
• Added a condition statement to the <i>Typical Characteristics</i> section	21
• Changed specific voltages to a <i>Recommended Operating Conditions</i> reference.....	24
• Changed unity-gain bandwidth from 0.7 MHz for all devices to 1.2 MHz for B-version devices.....	25
• Changed slew rate from 3 V/μs for all devices to 0.5 V/μs for B-version devices.....	25
• Changed the Input Common Mode Range section in multiple places throughout.....	25
• Changed V_{CC} to V_S in the Application Information section	26
• Subscripted the suffixes from R_I and R_F	26
• 已更改 <i>Operational Amplifier Board Layout for Noninverting Configuration</i> with an image that includes a dual op amp....	28
• 在表 1	29

Changes from Revision T (April 2015) to Revision U

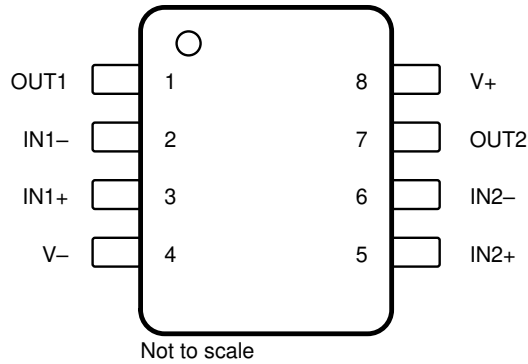
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5 Device Comparison Table

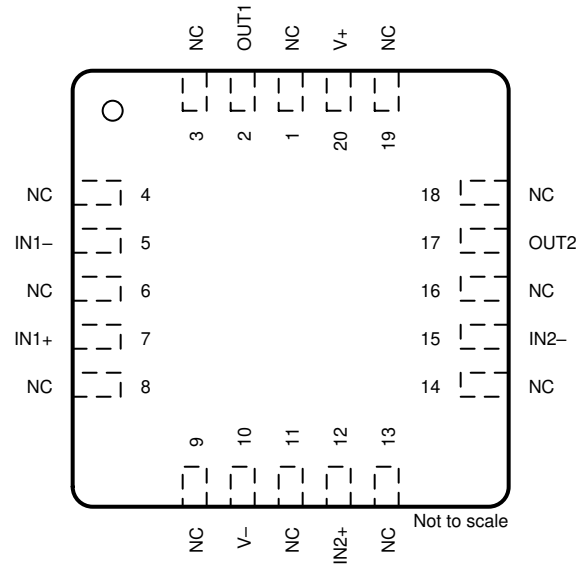
PART NUMBER	SUPPLY VOLTAGE	TEMPERATURE RANGE	V _{OS} (MAXIMUM AT 25°C)	I _Q / CH (TYPICAL AT 25°C)	INTEGRATED EMI FILTER	PACKAGE
LM358B	3 V–36 V	–40°C to 85°C	3 mV	300 µA	Yes	D, DGK, PW
LM2904B	3 V–36 V	–40°C to 125°C	3 mV	300 µA	Yes	D, DGK, PW
LM358	3 V–32 V	0°C to 70°C	7 mV	350 µA	No	D, PW, DGK, P, PS
LM2904	3 V–26 V	–40°C to 125°C	7 mV	350 µA	No	D, PW, DGK, P, PS
LM358A	3 V–32 V	0°C to 70°C	3 mV	350 µA	No	D, PW, DGK, P
LM2904V	3 V–32 V	–40°C to 125°C	7 mV	350 µA	No	D, PW
LM158	3 V–32 V	–55°C to 125°C	5 mV	350 µA	No	JG, FK
LM158A	3 V–32 V	–55°C to 125°C	3 mV	350 µA	No	JG, FK
LM258	3 V–32 V	–25°C to 85°C	5 mV	350 µA	No	D, DGK, P
LM258A	3 V–32 V	–25°C to 85°C	3 mV	350 µA	No	D, DGK, P

6 Pin Configuration and Functions

**D, DGK, P, PS, PW, and JG Packages
8-Pin SOIC, VSSOP, PDIP, SO, TSSOP, and CDIP
Top View**



**FK Package
20-Pin LCCC
Top View**



NC - No internal connection

7 Specifications

7.1 Absolute Maximum Ratings

over operating ambient temperature range (unless otherwise noted)⁽¹⁾

		MIN	MAX	UNIT	
Supply voltage, $V_S = ([V+] - [V-])$	LM358B, LM358BA, LM2904B, LM2904BA		±20 or 40	V	
	LM158, LM258, LM358, LM158A, LM258A, LM358A, LM2904V		±16 or 32		
	LM2904		±13 or 26		
Differential input voltage, V_{ID} ⁽²⁾	LM358B, LM358BA, LM2904B, LM2904BA, LM158, LM258, LM358, LM158A, LM258A, LM358A, LM2904V	–32	32	V	
	LM2904	–26	26		
Input voltage, V_I	Either input	LM358B, LM358BA, LM2904B, LM2904BA	–0.3	40	V
		LM158, LM258, LM358, LM158A, LM258A, LM358A, LM2904V	–0.3	32	

7.3 Recommended Operating Conditions

over operating ambient temperature range (unless otherwise noted)

		MIN	MAX	UNIT	
V _S	Supply voltage, V _S = ([V+] – [V–])	LM358B, LM358BA, LM2904B, LM2904BA		V	
		LM158, LM258, LM358, LM158A, LM258A, LM358A, LM2904V			
		LM2904			
V _{CM}	Common-mode voltage	V–	V+ – 2	V	
T _A	Operating ambient temperature	LM358B, LM358BA		°C	
		LM2904B, LM2904BA, LM2904, LM2904V			
		LM358, LM358A			
		LM258, LM258A			

7.5 Electrical Characteristics: LM358B and LM358BA

$V_S = (V+) - (V-) = 5\text{ V} - 36\text{ V} (\pm 2.5\text{ V} - \pm 18\text{ V})$, $T_A = 25^\circ\text{C}$, $V_{CM} = V_{OUT} = V_S/2$, $R_L = 10\text{ k}\Omega$ connected to $V_S/2$
(unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
OFFSET VOLTAGE							
V_{OS}	Input offset voltage	LM358B			± 0.3	± 3.0	mV
			$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$			± 4	mV
		LM358BA				± 2.0	mV
			$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$			± 2.5	mV
dV_{OS}/dT	Input offset voltage drift		$T_A = -40^\circ\$				

7.6 Electrical Characteristics: LM2904B and LM2904B

 $V_S = (V+) - (V-) = 5\text{ V} - 36\text{ V} (\pm 2.5\text{ V} - \pm 18\text{ V})$, $T_A = 25^\circ\text{C}$, $V_{CM} = V_{OUT} = V_S/2$, $R_L = 10\text{ k}\Omega$ connected to $V_S/2$

(unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
OFFSET VOLTAGE							
V_{OS}	Input offset voltage	LM2904B			± 0.3	± 3.0	mV
			$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$			± 4	mV
		LM2904BA				± 2.0	mV
			$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$			± 2.5	mV

7.7 Electrical Characteristics: LM358, LM358A

For $V_S = (V_+) - (V_-) = 5\text{ V}$, $T_A = 25^\circ\text{C}$, (unless otherwise noted)

PARAMETER		TEST CONDITIONS ⁽¹⁾		MIN	TYP ⁽²⁾	MAX	UNIT
OFFSET VOLTAGE							
V_{OS}	Input offset voltage	$V_S = 5\text{ V to }30\text{ V}; V_{CM} = 0\text{ V}; V_O = 1.4\text{ V}$	LM358	$T_A = 0^\circ\text{C to }70^\circ\text{C}$	3	7	mV
						9	
			LM358A	$T_A = 0^\circ\text{C to }70^\circ\text{C}$	2	3	
						5	
dV_{OS}/dT	Input offset voltage drift						

7.8 Electrical Characteristics: LM2904, LM2904V

For $V_S = (V+) - (V-) = 5\text{ V}$, $T_A = 25^\circ\text{C}$, (unless otherwise noted)

PARAMETER		TEST CONDITIONS ⁽¹⁾		MIN	TYP ⁽²⁾	MAX	UNIT
OFFSET VOLTAGE							
V_{OS}	Input offset voltage	$V_S = 5\text{ V}$ to maximum; $V_{CM} = 0\text{ V}$; $V_O = 1.4\text{ V}$	Non-A suffix devices			3	mV
				$T_A = -40^\circ\text{C}$ to 125°C		7	
			A-suffix devices			10	
				$T_A = -40^\circ\text{C}$ to 125°C		2	
dV_{OS}/dT							

7.9 Electrical Characteristics: LM158, LM158A

For $V_S = (V_+) - (V_-) = 5\text{ V}$, $T_A = 25\text{ }^\circ\text{C}$, (unless otherwise noted)

PARAMETER		TEST CONDITIONS ⁽¹⁾		MIN	TYP ⁽²⁾	MAX	UNIT
OFFSET VOLTAGE							
V_{OS}	Input offset voltage	$V_S = 5\text{ V to }30\text{ V}$; $V_{CM} = 0\text{ V}$; $V_O = 1.4\text{ V}$	LM158	$T_A = -55^\circ\text{C to }125^\circ\text{C}$	3	5	mV
						7	
			LM158A	$T_A = -55^\circ\text{C to }125^\circ\text{C}$		2	
						4	

7.10 Electrical Characteristics: LM258, LM258A

For $V_S = (V_+) - (V_-) = 5\text{ V}$, $T_A = 25\text{ }^\circ\text{C}$, (unless otherwise noted)

PARAMETER		TEST CONDITIONS ⁽¹⁾		MIN	TYP ⁽²⁾	MAX	UNIT
OFFSET VOLTAGE							
V_{OS}	Input offset voltage	$V_S = 5\text{ V to }30\text{ V}$; $V_{CM} = 0\text{ V}$; $V_O = 1.4\text{ V}$	LM258	$T_A = -25^\circ\text{C to }85^\circ\text{C}$	3	5	mV
						7	
			LM258A	$T_A = -25^\circ\text{C to }85^\circ\text{C}$	2	3	
						4	

7.11 Typical Characteristics

Typical characteristics section is applicable for LM358B and LM2904B. The typical characteristics data section was taken with $T_A = 25^\circ\text{C}$, $V_S = 36\text{ V}$ ($\pm 18\text{ V}$), $V_{CM} = V_S / 2$, $R_{LOAD} = 10\text{ k}\Omega$ connected to $V_S / 2$ (unless otherwise noted).

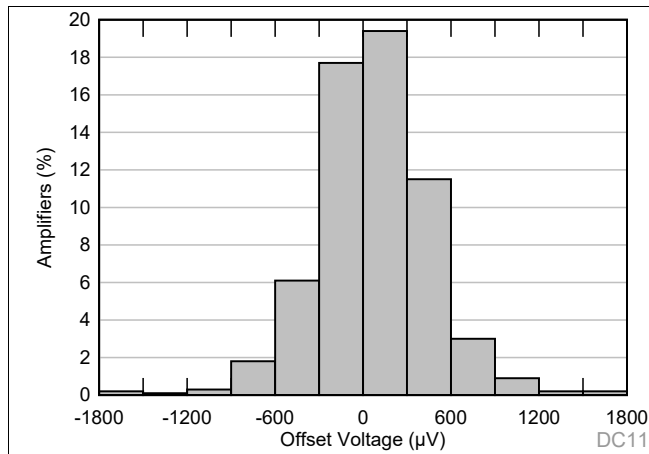


图 1. Offset Voltage Production Distribution

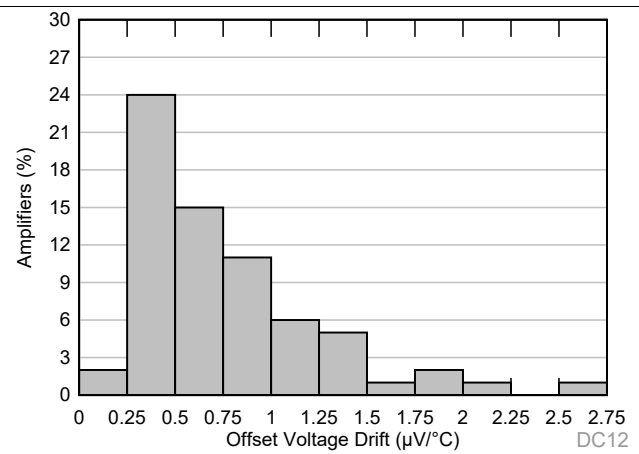
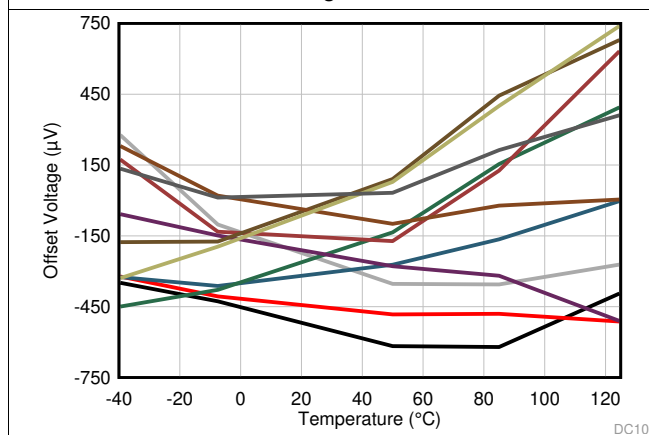


图 2. Offset Voltage Drift Distribution



Typical Characteristics (接下页)

Typical characteristics section is applicable for LM358B and LM2904B. The typical characteristics data section was taken with $T_A = 25^\circ\text{C}$, $V_S = 36\text{ V}$ ($\pm 18\text{ V}$), $V_{CM} = V_S / 2$, $R_{LOAD} = 10\text{ k}\Omega$ connected to $V_S / 2$ (unless otherwise noted).

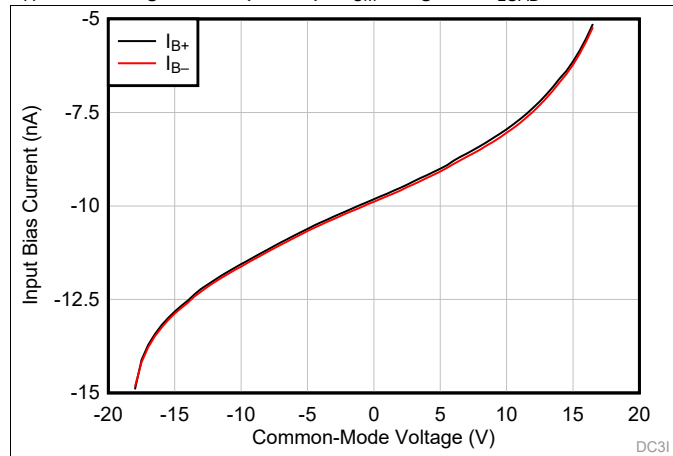


图 7. Input Bias Current vs Common-Mode Voltage

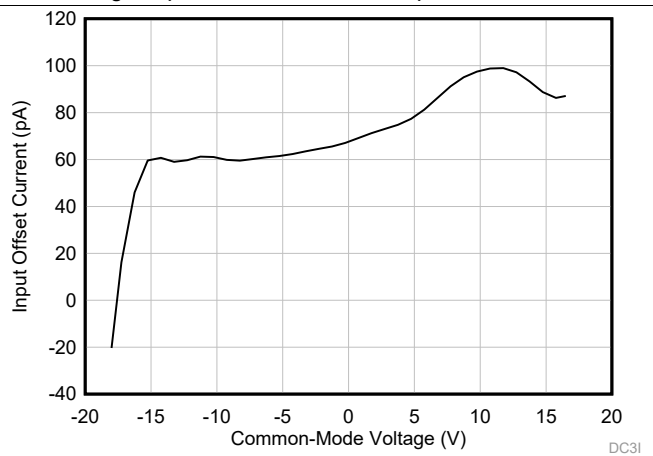
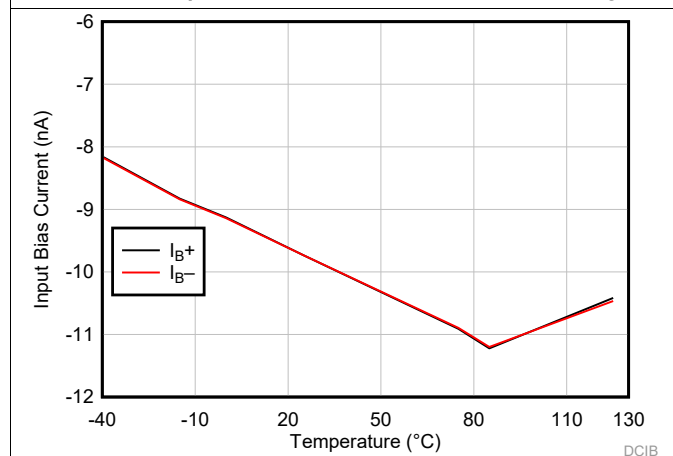


图 8. Input Offset Current vs Common-Mode Voltage



Typical Characteristics (接下页)

Typical characteristics section is applicable for LM358B and LM2904B. The typical characteristics data section was taken with $T_A = 25^\circ\text{C}$, $V_S = 36\text{ V}$ ($\pm 18\text{ V}$), $V_{CM} = V_S / 2$, $R_{LOAD} = 10\text{ k}\Omega$ connected to $V_S / 2$ (unless otherwise noted).

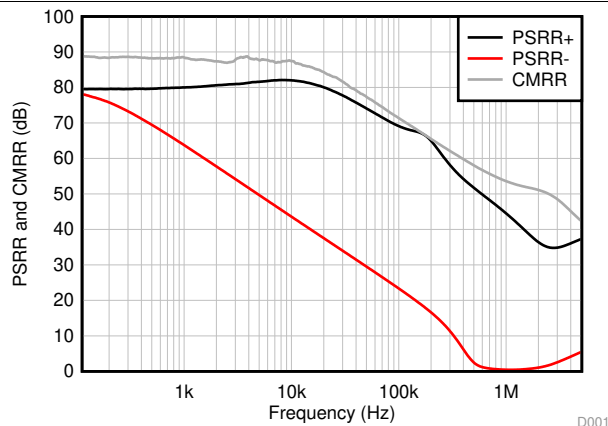


图 13. CMRR and PSRR vs Frequency

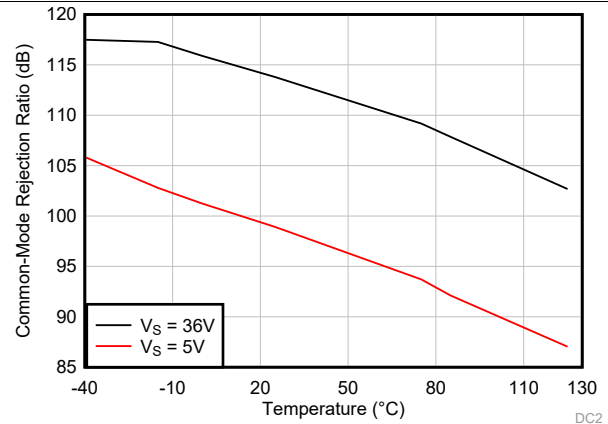
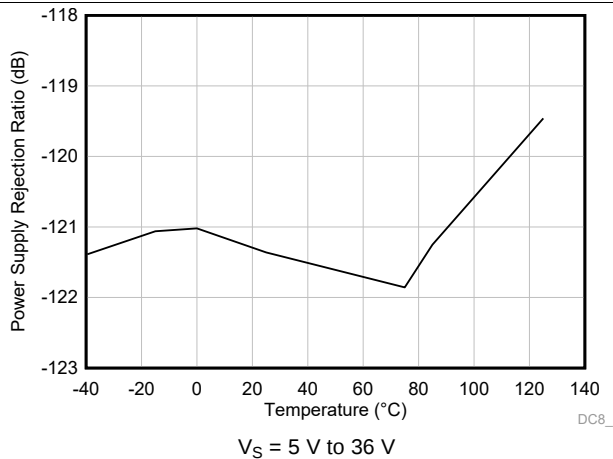
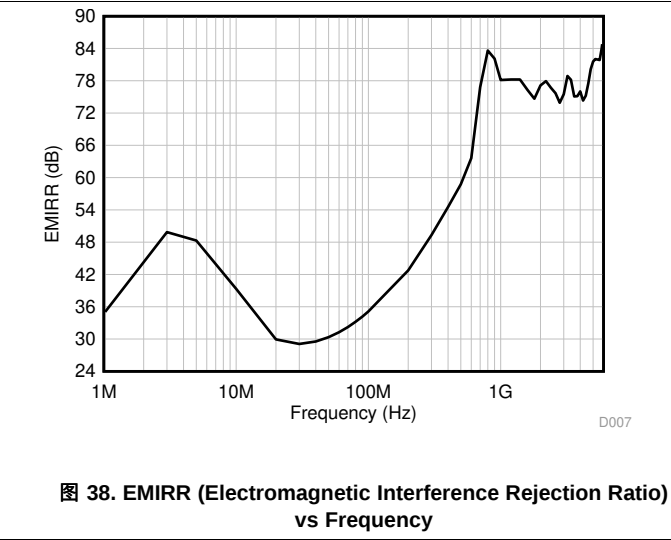
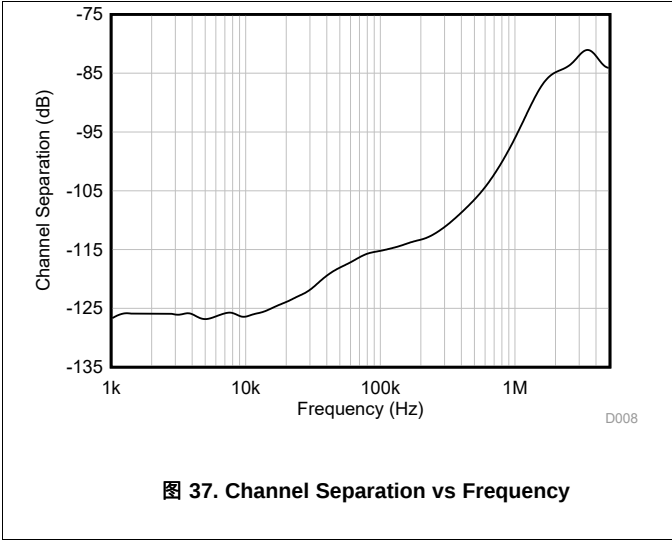


图 14. Common-Mode Rejection Ratio vs Temperature (dB)



Typical Characteristics (接下页)

Typical characteristics section is applicable for LM358B and LM2904B. The typical characteristics data section was taken with $T_A = 25^\circ\text{C}$, $V_S = 36\text{ V}$ ($\pm 18\text{ V}$), $V_{CM} = V_S / 2$, $R_{LOAD} = 10\text{ k}\Omega$ connected to $V_S / 2$ (unless otherwise noted).



7.12 Typical Characteristics

Typical characteristics section is applicable for LM158, LM158A, LM258, LM258A, LM358, LM358A, LM2904, and LM2904V.

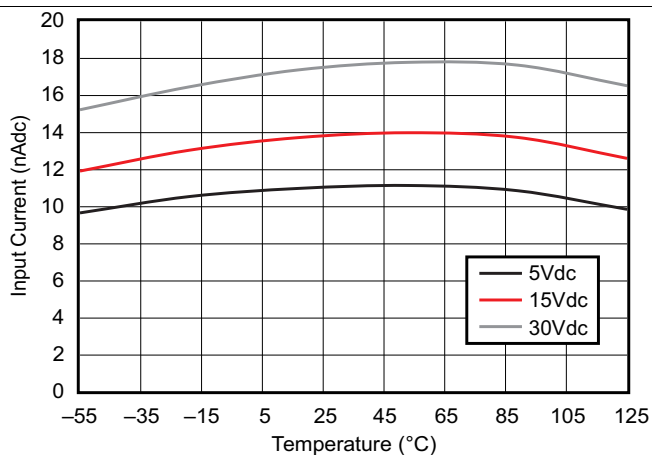


图 39. Input Current vs Temperature

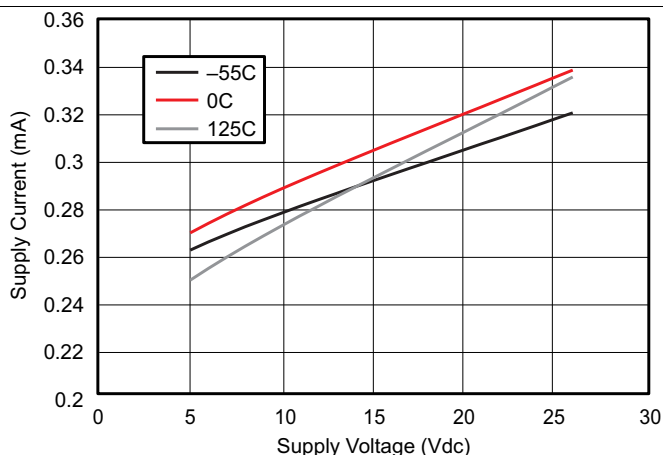


图 40. Supply Current vs Supply Voltage

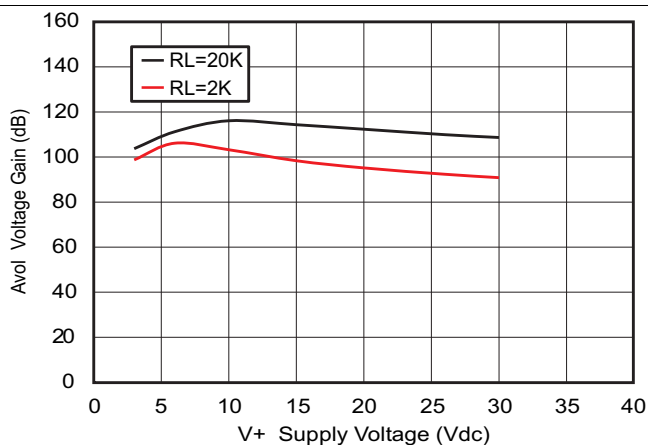
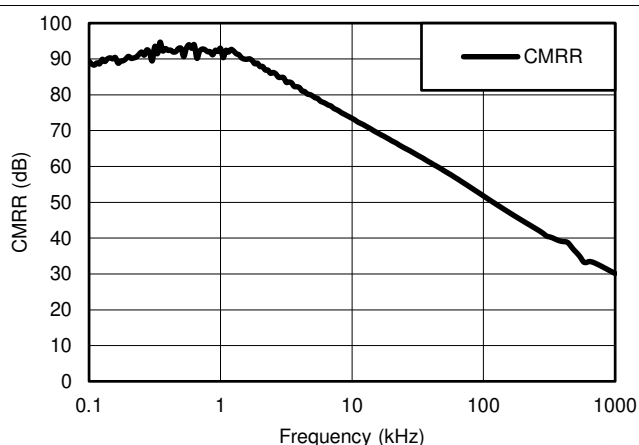


图 41. Voltage Gain vs Supply Voltage



Typical Characteristics (接下页)

Typical characteristics section is applicable for LM158, LM158A, LM258, LM258A, LM358, LM358A, LM2904, and LM2904V.

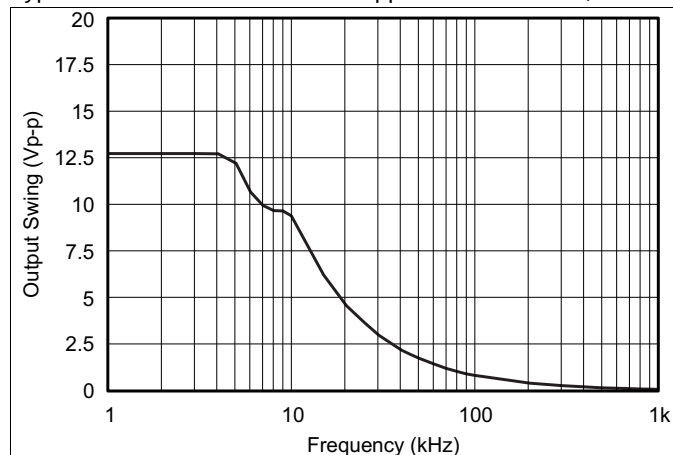


图 45. Maximum Output Swing vs Frequency
($V_{CC} = 15\text{ V}$)

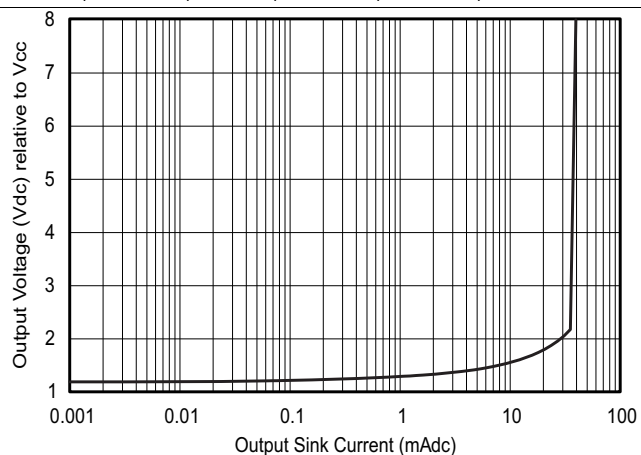


图 46. Output Sourcing Characteristics

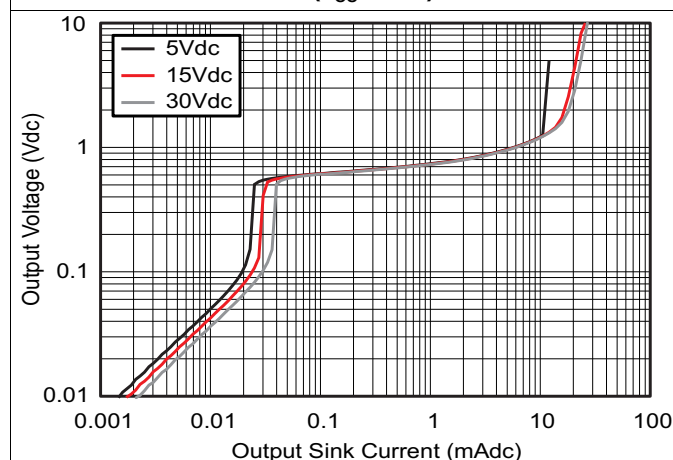


图 47. Output Sinking Characteristics

8 Parameter Measurement Information

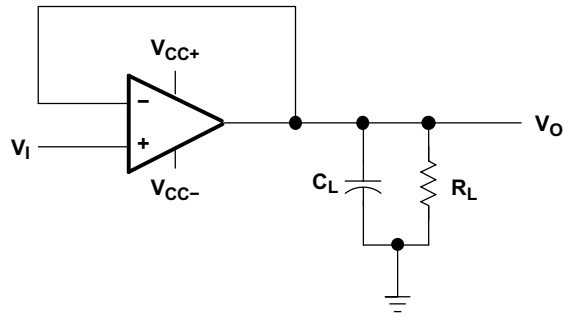


图 49. Unity-Gain Amplifier

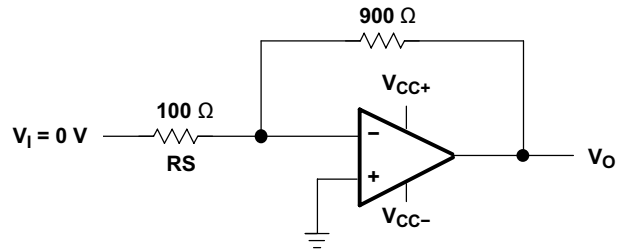


图 50. Noise-Test Circuit

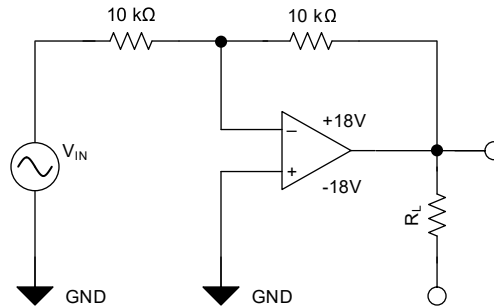


图 51. Test Circuit, $G = -1$, for THD+N and Small-Signal Step Response

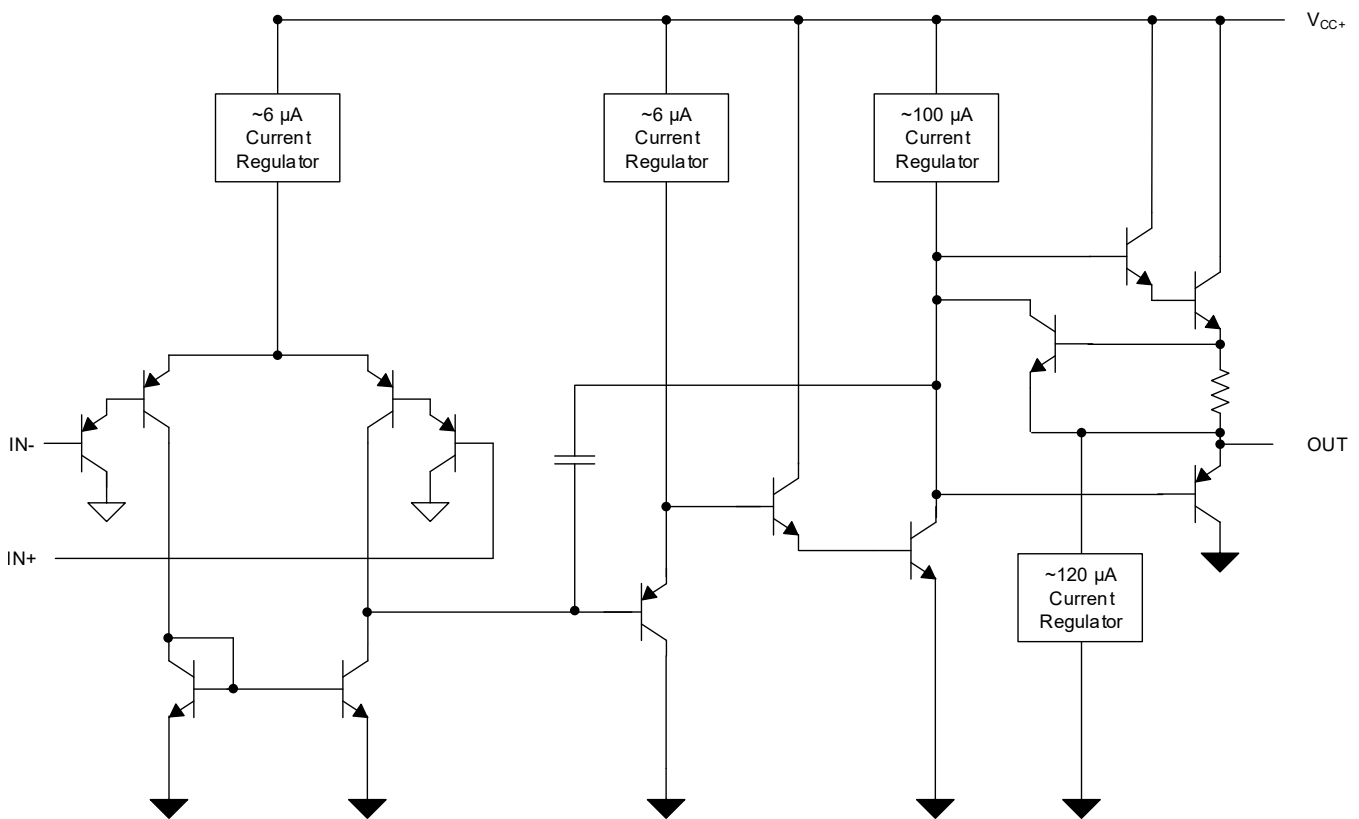
9 Detailed Description

9.1 Overview

These devices consist of two independent, high-gain frequency-compensated operational amplifiers designed to operate from a single supply over a wide range of voltages. Operation from split supplies also is possible if the difference between the two supplies is within the supply voltage range specified in the [Recommended Operating Conditions](#) section, and V_S is at least 1.5 V more positive than the input common-mode voltage. The low supply-current drain is independent of the magnitude of the supply voltage.

Applications include transducer amplifiers, dc amplification blocks, and all the conventional operational amplifier circuits that now can be implemented more easily in single-supply-voltage systems. For example, these devices can be operated directly from the standard 5-V supply used in digital systems and easily can provide the required interface electronics without additional ± 5 -V supplies.

9.2 Functional Block Diagram - LM358B, LM358BA, LM2904B, LM2904BA



9.3 Feature Description

9.3.1 Unity-Gain Bandwidth

The unity-gain bandwidth is the frequency up to which an amplifier with a unity gain may be operated without greatly distorting the signal. These devices have a 1.2-MHz unity-gain bandwidth (B Version).

9.3.2 Slew Rate

The slew rate is the rate at which an operational amplifier can change its output when there is a change on the input. These devices have a 0.5-V/ μ s slew rate (B Version).

9.3.3 Input Common Mode Range

The valid common mode range is from device ground to $V_S - 1.5\text{ V}$ ($V_S - 2\text{ V}$ across temperature). Inputs may exceed V_S up to the maximum V_S without device damage. At least one input must be in the valid input common-mode range for the output to be the correct phase. If both inputs exceed the valid range, then the output phase is undefined. If either input more than 0.3 V below V_- then input current should be limited to 1 mA and the output phase is undefined.

9.4 Device Functional Modes

These devices are powered on when the supply is connected. This device can be operated as a single-supply operational amplifier or dual-supply amplifier, depending on the application.

12.2 Layout Examples

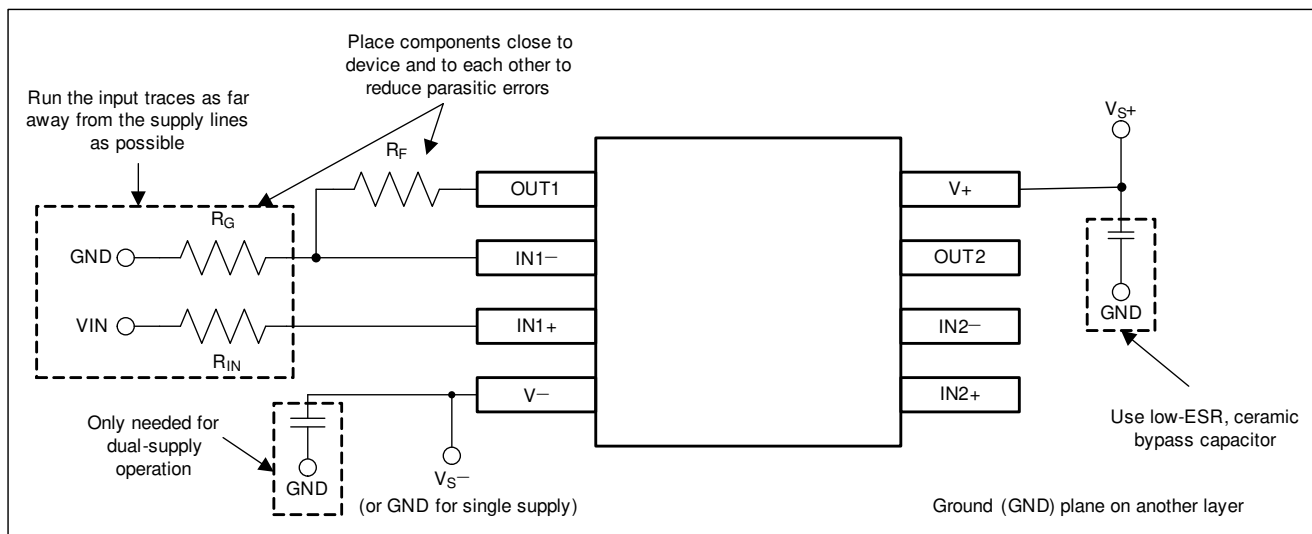


图 54. Operational Amplifier Board Layout for Noninverting Configuration

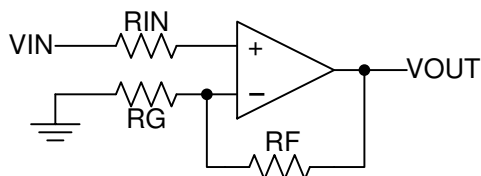


图 55. Operational Amplifier Schematic for Noninverting Configuration

14 机械、封装和可订购信息

以下页中包括机械、封装和可订购信息。这些信息是针对指定器件可提供的最新数据。数据如有变更，恕不另行通知和修订此文档。如需获取此数据表的浏览器版本，请查看左侧的导航面板。

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM358PWRG4-JF	TSSOP	PW	8	2000	853.0	449.0	35.0

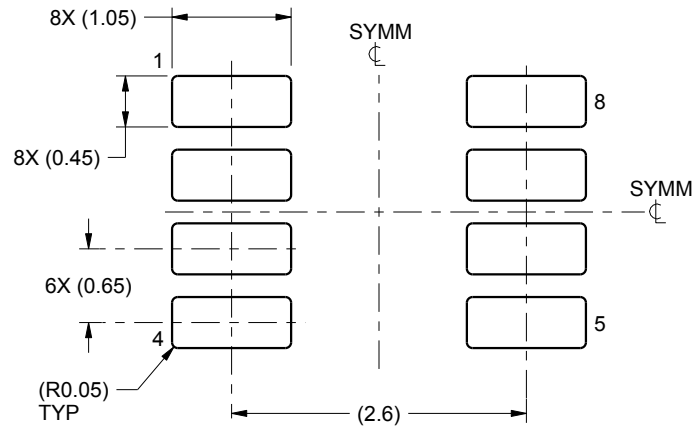
Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
LM358ADE4	D	SOIC	8	75	506.6	8	3940	4.32
LM358ADE4	D	SOIC	8	75	507	8	3940	4.32
LM358ADG4	D	SOIC	8	75	506.6	8	3940	4.32
LM358ADG4	D	SOIC	8	75	507	8	3940	4.32
LM358AP	P	PDIP	8	50	506.1	9	600	5.4
LM358AP	P	PDIP	8	50	506	13.97	11230	4.32
LM358APE4	P	PDIP	8	50	506	13.97	11230	4.32
LM358APW	PW	TSSOP	8	150	530	10.2	3600	3.5
LM358D	D	SOIC	8	75	506.6	8	3940	4.32
LM358D	D	SOIC	8	75	507	8	3940	4.32
LM358D-JF	D	SOIC	8	75	506.6	8	3940	4.32
LM358D-JF</								

EXAMPLE BOARD LAYOUT

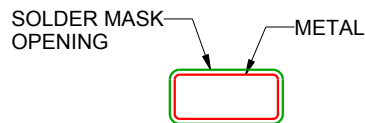
DDF0008A

SOT-23 - 1.1 mm max height

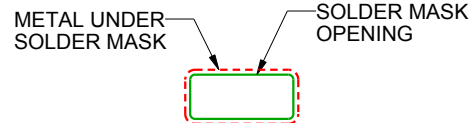
PLASTIC SMALL OUTLINE



LAND PATTERN EXAMPLE
SCALE:15X



NON SOLDER MASK
DEFINED



SOLDER MASK
DEFINED

SOLDER MASK DETAILS

4222047/B 11/2015

NOTES: (continued)

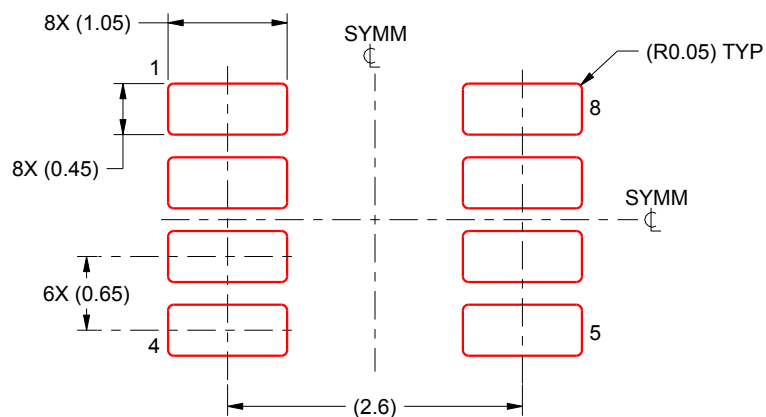
4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DDF0008A

SOT-23 - 1.1 mm max height

PLASTIC SMALL OUTLINE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

4222047/B 11/2015

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
7. Board assembly site may have different recommendations for stencil design.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

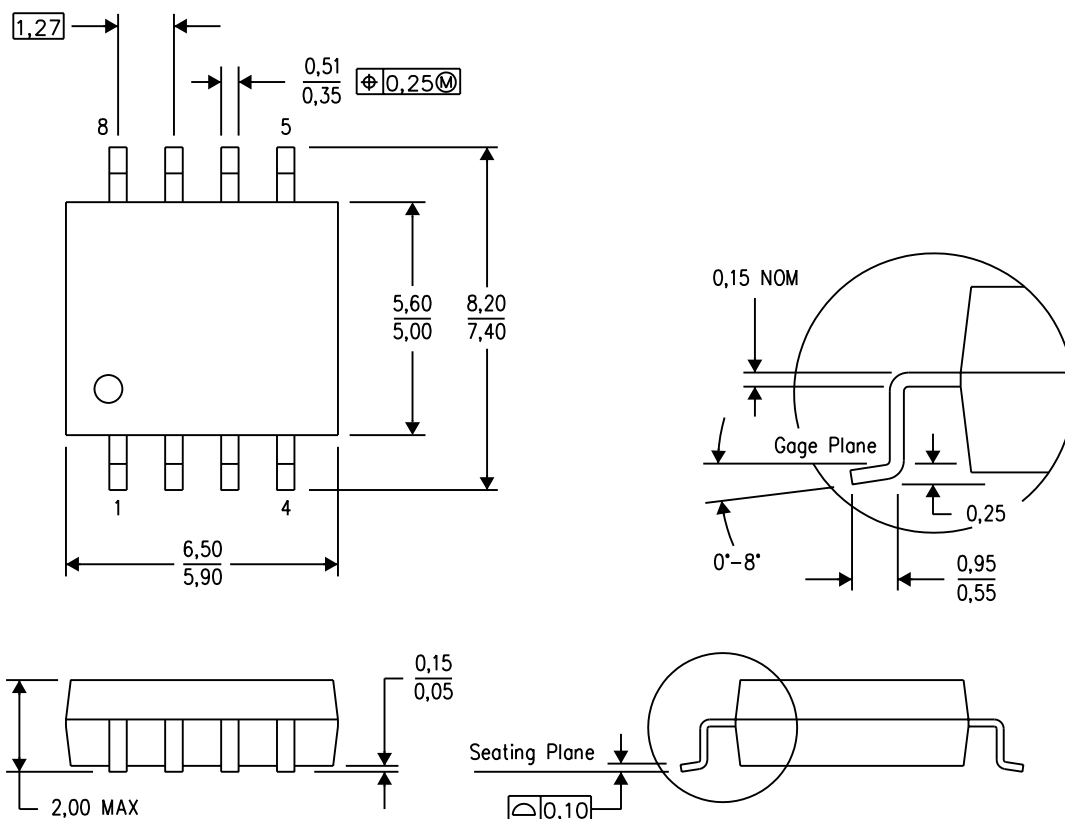
NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

MECHANICAL DATA

PS (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE

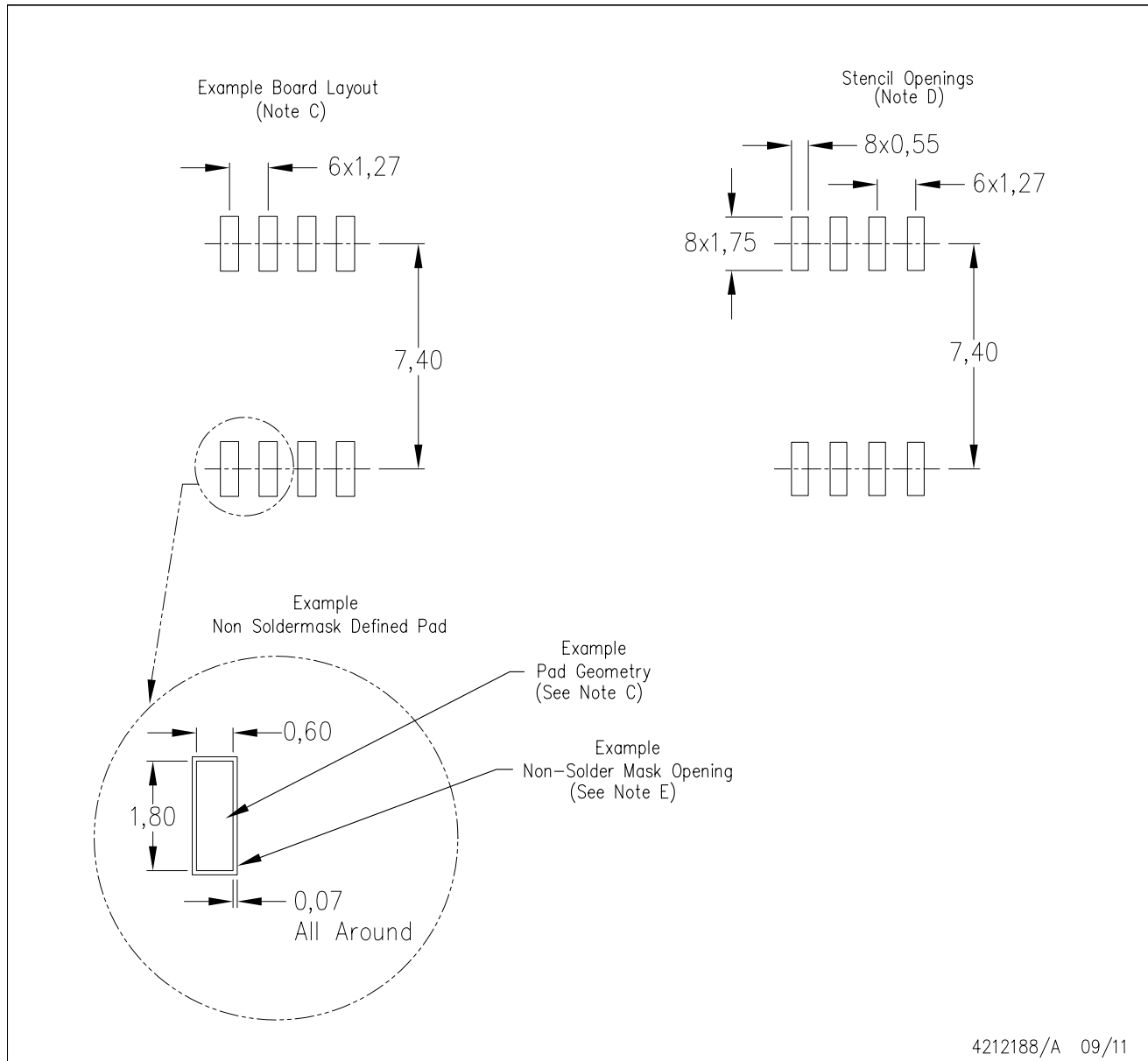


4040063/C 03/03

- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

PS (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

P (R-PDIP-T8)

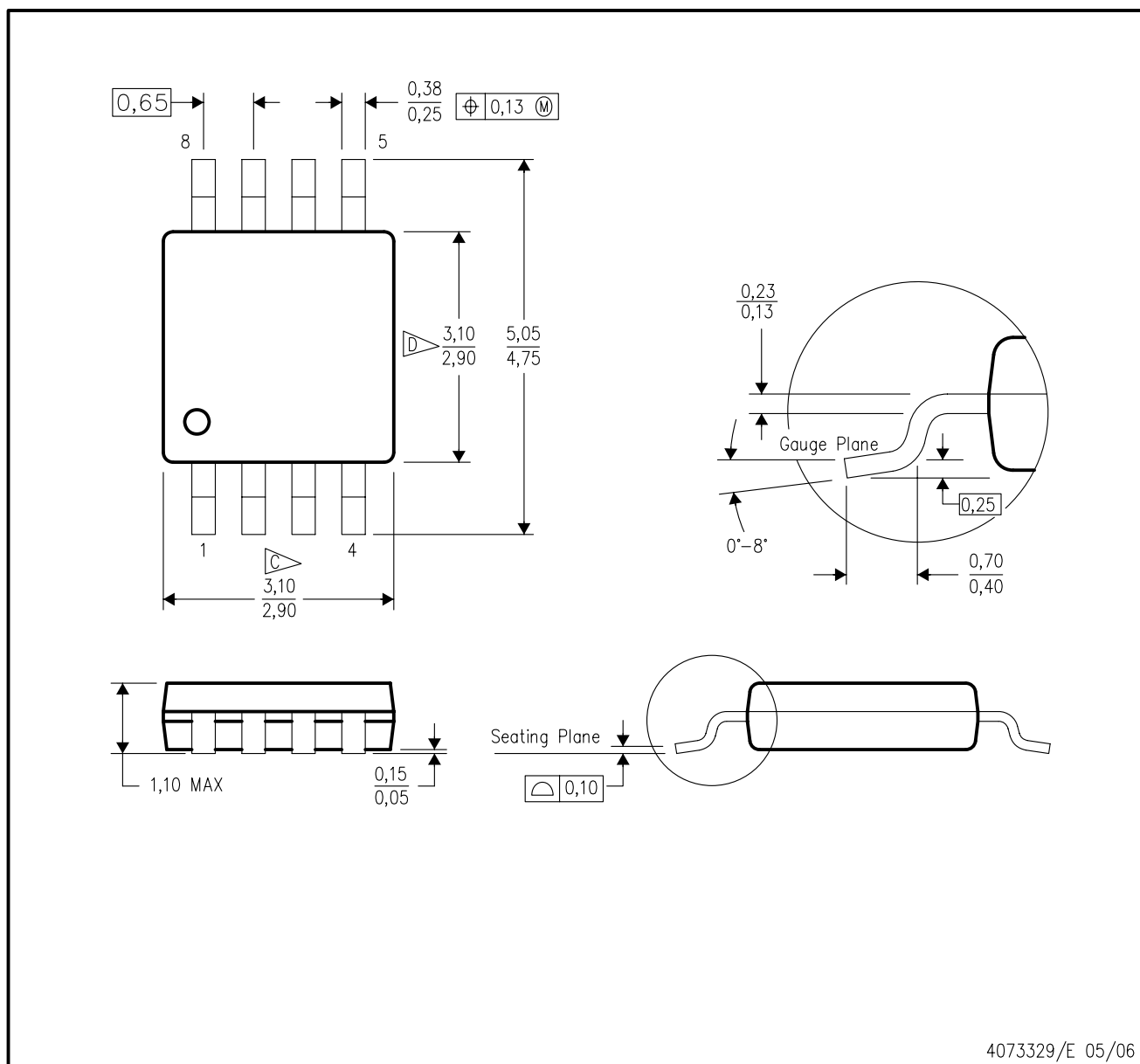
PLASTIC DUAL-IN-LINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Falls within JEDEC MS-001 variation BA.

DGK (S-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



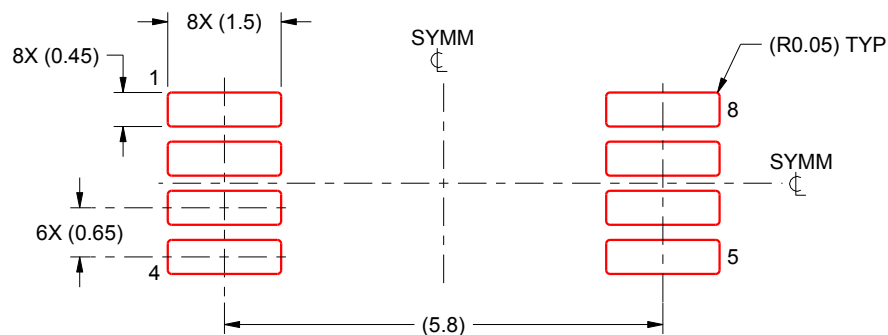
- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions

EXAMPLE STENCIL DESIGN

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:10X

4221848/A 02/2015

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

