Industry-standard Dual Operational Amplifiers

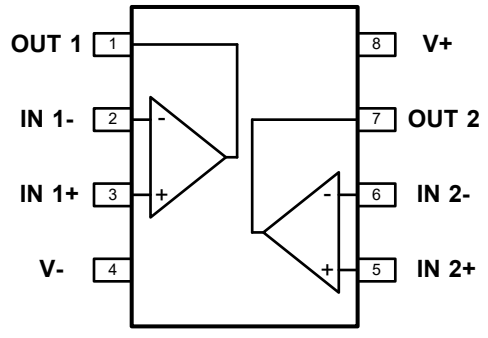
LM358E, LM2904E Operational Amplifiers

1 Introduction

The LM358E and the LM2904E are industry standard operational amplifiers. They consist of two independent operational amplifiers, each with high gain and low power consumption characteristics. The LM358E is equivalent to half of the LM324, and the LM2904E has a wider operating temperature range than the LM358E. The LM358E and the LM2904E can operate at power voltages as low as 3.0V or as high as 36V, and support single or dual power supply. Therefore, the LM358E and the LM2904E are widely used in various application circuits, such as audio amplifiers, DC gain components, and traditional operational amplifier circuits.

2 Applications

- Computer and motherboard
- Household electric appliances
- Inverter circuit
- Motor control
- Multi-functional printer
- Power supply and portable charger
- Uninterruptible power supply (UPS)



Pin Connections

3 Features

- Power Supply Range:
  - Single supply: 3.0 to 36V
  - Dual supplies: ±1.5 to ±18V
- Two Independent Operational Amplifiers Built-in:
  - Equivalent to one-half of an LM324
  - Quiescent current of 200μA / channel
- Low Input Offset Voltage:
  0.5mV (Typ.) at 25°C
- Low Input Bias Current:
  45nA (Typ.) at 25°C
- Unity-gain Bandwidth: 1.0MHz (Typ.)
- Wide operating ambient temperature:
  - LM358E: -40 ~ 85°C
  - LM2904E: -40 ~ 125°C
- Internally frequency compensated for unity gain
- Common-mode input voltage range includes ground

4 Available Packages

PART NUMBER	PACKAGE
LM358E-PAN	SOP8
LM358E-PDN	MSOP8
LM2904E-PAN	SOP8
LM2904E-PDN	MSOP8

5 Orderable Information

MODEL	DEVICE	PACKAGE	OP TEMP	ECO PLAN	MSL	PACKING OPTION	SORT
LM358E	LM358E-PAN	SOP8	-40 ~ 85°C	RoHS & Green	Level 3 168 HR	Tape and Reel 4000 Units / Reel	Active
	LM358E-PDN	MSOP8	-40 ~ 85°C	RoHS & Green	Level 3 168 HR	Tape and Reel 4000 Units / Reel	Active
LM2904E	LM2904E-PAN	SOP8	-40 ~ 125°C	RoHS & Green	Level 3 168 HR	Tape and Reel 4000 Units / Reel	Active
	LM2904E-PDN	MSOP8	-40 ~ 125°C	RoHS & Green	Level 3 168 HR	Tape and Reel 4000 Units / Reel	Active
Others	-	-	-	-	-	-	Customized

Note:

ECO PLAN: For the RoHS and Green certification standards of this product, please refer to the official report provided by SZCJ

MSL: Moisture Sensitivity Level. Determined according to JEDEC industry standard classification.

SORT: Specifically defined as follows:

Active: Recommended for new products;

Customized: Products manufactured to meet the specific needs of customers;

Preview: The device has been released and has not been fully mass produced. The sample may or may not be available;

NoRD: It is not recommended to use the device for new design. The device is only produced for the needs of existing customers; Obsolete: The device has been discontinued.

6 Pin Configuration and Marking Information

6.1 Pin Configuration and Function

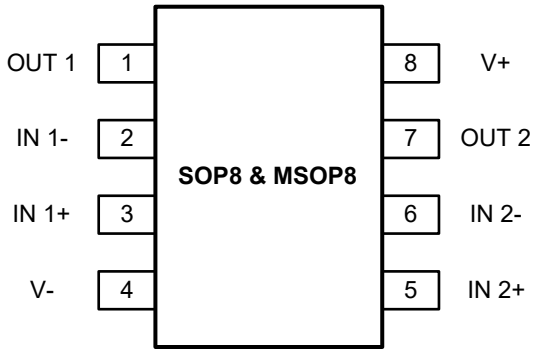
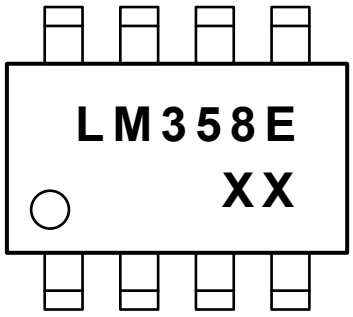


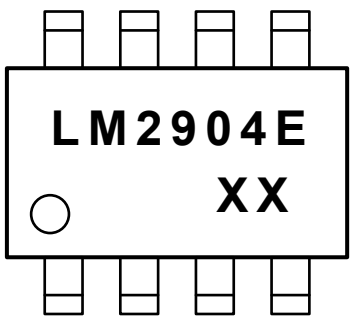
Figure 6-1. LM358E, LM2904E Pin Map

PIN NAME	LM358E, LM2904E SOP8 & MSOP8	I / O	DESCRIPTION
OUT 1	1	O	Output of the operational amplifier 1.
IN 1-	2	I	Negative input of the operational amplifier 1.
IN 1+	3	I	Positive input of the operational amplifier 1.
V-	4	-	Negative (lowest) supply or ground for single supply.
IN 2+	5	I	Positive input of the operational amplifier 2.
IN 2-	6	I	Negative input of the operational amplifier 2.
OUT 2	7	O	Output of the operational amplifier 2.
V+	8	-	Positive (highest) supply.

6.2 Marking Information



"**LM358E**": Device number.
"**XX**": Code, indicates weekly record information.



"**LM2904E**": Device number.
"**XX**": Code, indicates weekly record information.

(For SOP8 and MSOP8 packages)

7 Specifications

7.1 Absolute Maximum Ratings

(over operating ambient temperature range, unless otherwise specified)(1)

CHARACTERISTIC		SYMBOL	VALUE	UNIT
Maximum power supply	Single supply	V_S	40	V
	Dual supplies		±20	
Maximum differential input range(2)		V_{ID}	-32 ~ 32	V
Maximum input range (either input)		V_{IN}	-0.3 ~ 40	V
Duration of output short circuit (one amplifier) to ground (or below) at T_A = 25°C, V_S ≤ 15V		t_{SC}	Continuous(3)	s
Maximum junction temperature		$T_{J\ MAX}$	150	°C
Storage temperature		T_{stg}	-65 ~ 150	°C
Soldering temperature & time		T_{solder}	260°C, 10s	-

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum rated conditions for extended periods may affect device reliability.

(2) Differential voltages are at IN+, with respect to IN−.

(3) Short circuits from outputs to V_S can cause excessive heating and eventual destruction. A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

7.2 Recommend Operating Conditions

(over operating ambient temperature range, unless otherwise specified)

PARAMETER		SYMBOL	MIN.	NOM.	MAX.	UNIT
Power supply range	Single supply	V_S	3.0	-	36	V
	Dual supplies		±1.5	-	±18	
Common-mode voltage range		V_{CM}	V-	-	(V+) - 2.0	V
Operating ambient temperature	LM358E	T_A	-40	-	85	°C
	LM2904E		-40	-	125	

7 Specifications

7.3 ESD Ratings

ESD RATINGS			SYMBOL	VALUE	UNIT
Electrostatic discharge(4)	Human body model	LM358E	$V_{ESD-HBM}$	4000	V
		LM2904E	$V_{ESD-HBM}$	400	V

(4) ESD testing is conducted in accordance with the relevant specifications formulated by the Joint Electronic Equipment Engineering Commission (JEDEC). The human body model (HBM) electrostatic discharge test is based on the JESD22-A114D test standard, using a 100pF capacitor and discharging to each pin of the device through a resistance of 1.5kΩ.

7.4 Thermal Information

THERMAL METRIC(5)	SYMBOL	LM358E, LM2904E		UNIT
		SOP8	MSOP8	
Junction-to-ambient thermal resistance	$R_{\Theta JA}$	165.0	220.0	°C/W
Junction-to-case thermal resistance	$R_{\Theta JC}$	45.0	50.0	°C/W
Reference maximum power dissipation (continuous)	$P_{D\ Ref}$	0.61	0.45	W

(5) T_A = 25°C, measured on evaluation board with 1oz. copper traces of minimum pad size, all device outputs were active.

7 Specifications

7.5 Electrical Characteristics

LM358E (V_S = (V+) - (V-) = 5.0V, T_A = 25°C, unless otherwise specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS[6]			MIN.	TYP.	MAX.	UNIT
Offset Voltage								
Input offset voltage	V_{OS}	V_S = 5.0 to 30V, V_{CM} = 0V, V_{OUT} = 1.4V		T_A = 25°C	-	0.5	3.0	mV
				Full range	-	-	5.0	
Input offset voltage vs power supply (ΔV_{IO} / ΔV_S)	PSRR	V_S = 5.0 to 30V			65	100	-	dB
Input offset voltage drift	dV_{OS} / dT	-		Full range	-	4.0	-	µV / °C
Channel separation	CS	f = 1k to 20kHz			-	120	-	dB
Input Voltage Range								
Common-mode voltage range	V_{CM}	V_S = 5.0 to 30V		T_A = 25°C	V-	-	(V+) - 1.5	V
				Full range	V-	-	(V+) - 2.0	
Common-mode rejection ratio	CMRR	V_S = 5.0 to 30V; V_{CM} = 0V			70	80	-	dB
Power Supply								
Quiescent current both amplifiers	I_Q	V_S = 5.0V, R_L = ∞			-	0.4	1.2	mA
		V_S = 30V, R_L = ∞			-	0.7	2.0	mA
Input Bias Current								
Input bias current	I_{IB}	V_{CM} = 0V, V_{OUT} = 1.4V		T_A = 25°C	-	±25	±150	nA
				Full range	-	-	±250	
Input offset current	I_{OS}	V_{CM} = 0V, V_{OUT} = 1.4V		T_A = 25°C	-	±3.0	±30	nA
				Full range	-	-	±150	
Frequency Response								
Gain bandwidth product	GBW	-			-	1.0	-	MHz
Slew rate	SR	G = +1			-	0.4	-	V / µs
Output								
Voltage output swing from rail	V_{OUT}	V_S = 30V, R_L ≥ 10kΩ	Positive rail	T_A = 25°C	-	2.0	3.0	V
				Full range	-	2.5	-	
		V_S = 30V, R_L = 2kΩ		T_A = 25°C	-	3.0	4.0	
				Full range	-	3.5	-	
		V_S = 5.0V, R_L = 10kΩ	Negative rail	Full range	-	5.0	20	mV
Output current	I_{OUT}	V_S = 15V, V_{OUT} = 0V, V_{ID} = 1V, Source			20	40	-	mA
		V_S = 15V, V_{OUT} =2V, V_{ID} = -1V, Sink			10	15	-	mA
		V_{OUT} =0.2V, V_{ID} = -2V			12	50	-	µA
Short-circuit current	I_{SC}	V_S = 15V			-	±40	±60	mA
Open-loop Gain								
Open-loop voltage gain	A_{OL}	V_S = 15V, V_{OUT} = 1.0 to 11V, R_L ≥ 2kΩ			25	100	-	V / mV

7 Specifications

7.5 Electrical Characteristics (conitnued)

LM2904E (V_S = (V+) - (V-) = 5.0V, T_A = 25°C, unless otherwise specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS(6)			MIN.	TYP.	MAX.	UNIT
Offset Voltage								
Input offset voltage	V_{OS}	V_S = 5.0 to 30V, V_{CM} = 0V, V_{OUT} = 1.4V		T_A = 25°C	-	0.5	3.0	mV
				Full range	-	-	5.0	
Input offset voltage vs power supply (ΔV_{IO} / ΔV_S)	PSRR	V_S = 5.0 to 30V			65	100	-	dB
Input offset voltage drift	dV_{OS} / dT	-		Full range	-	4.0	-	µV / °C
Channel separation	CS	f = 1k to 20kHz			-	120	-	dB
Input Voltage Range								
Common-mode voltage range	V_{CM}	V_S = 5.0 to 30V		T_A = 25°C	V-	-	(V+) - 1.5	V
				Full range	V-	-	(V+) - 2.0	
Common-mode rejection ratio	CMRR	V_S = 5.0 to 30V; V_{CM} = 0V			70	80	-	dB
Power Supply								
Quiescent current both amplifiers	I_Q	V_S = 5.0V, R_L = ∞			-	0.4	1.2	mA
		V_S = 30V, R_L = ∞			-	0.7	2.0	mA
Input Bias Current								
Input bias current	I_{IB}	V_{CM} = 0V, V_{OUT} = 1.4V		T_A = 25°C	-	±25	±150	nA
				Full range	-	-	±250	
Input offset current	I_{OS}	V_{CM} = 0V, V_{OUT} = 1.4V		T_A = 25°C	-	±3.0	±30	nA
				Full range	-	-	±150	
Frequency Response								
Gain bandwidth product	GBW	-			-	1.0	-	MHz
Slew rate	SR	G = +1			-	0.4	-	V / µs
Output								
Voltage output swing from rail	V_{OUT}	V_S = 30V, R_L ≥ 10kΩ	Positive rail	T_A = 25°C	-	2.0	3.0	V
				Full range	-	2.5	-	
		V_S = 30V, R_L = 2kΩ		T_A = 25°C	-	3.0	4.0	
				Full range	-	3.5	-	
		V_S = 5.0V, R_L = 10kΩ	Negative rail	Full range	-	5.0	20	mV
Output current	I_{OUT}	V_S = 15V, V_{OUT} = 0V, V_{ID} = 1V, Source			20	40	-	mA
		V_S = 15V, V_{OUT} =2V, V_{ID} = -1V, Sink			10	15	-	mA
		V_{OUT} =0.2V, V_{ID} = -2V			12	50	-	µA
Short-circuit current	I_{SC}	V_S = 15V			-	±40	±60	mA
Open-loop Gain								
Open-loop voltage gain	A_{OL}	V_S = 15V, V_{OUT} = 1.0 to 11V, R_L ≥ 2kΩ			25	100	-	V / mV

7 Specifications

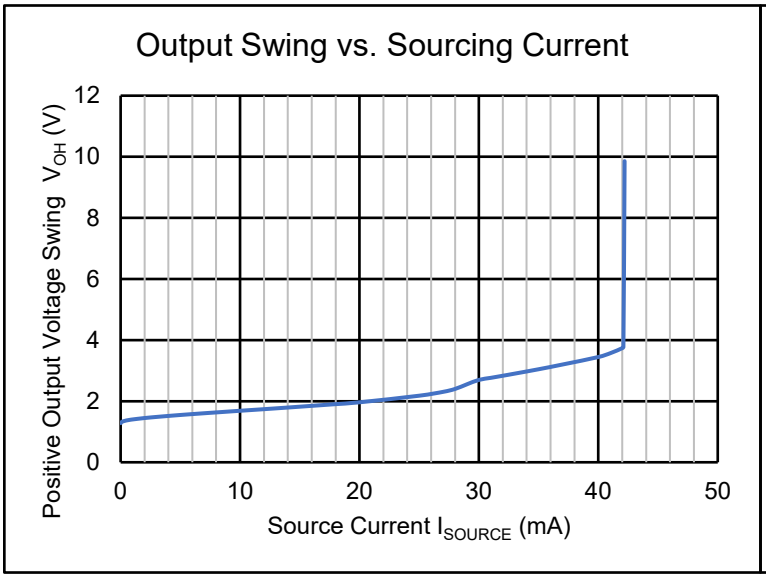
7.4 Electrical Characteristics (continued)

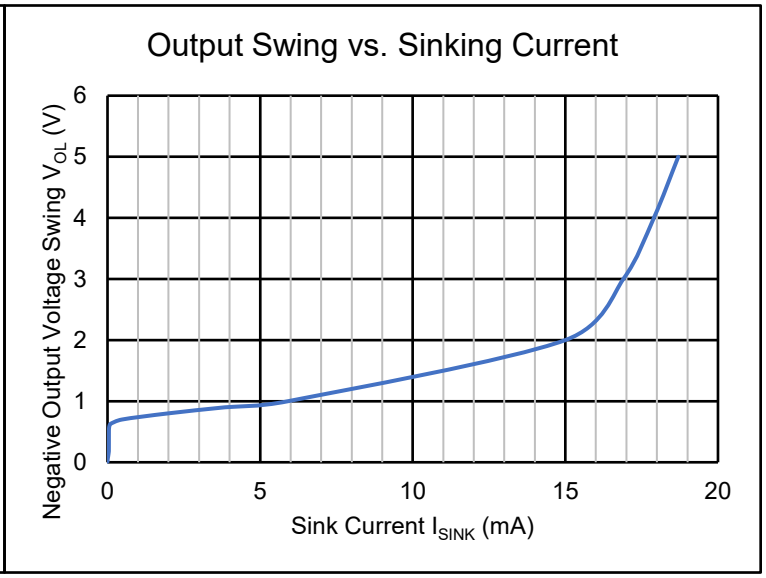
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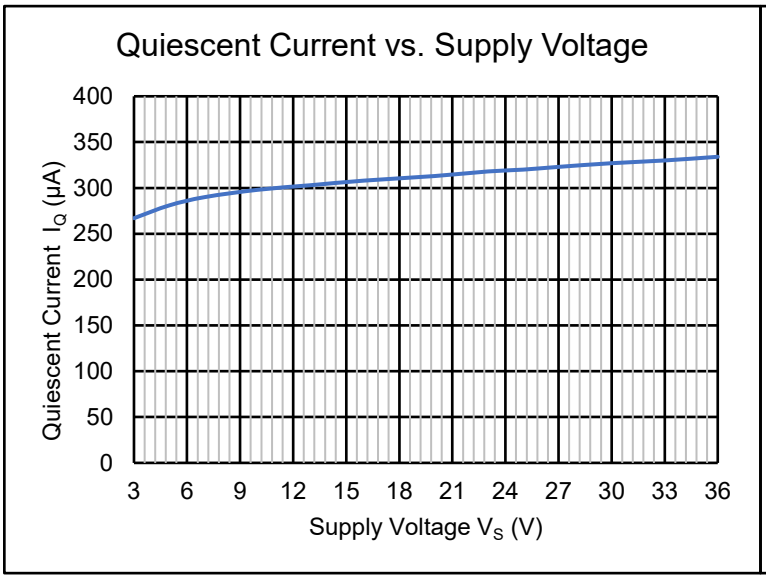
(6) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. All typical values are T_A = 25°C. For the LM358E, "Full range" refers to T_A ranging from -40 to 85°C. For the LM2904E, "Full range" refers to T_A ranging from -40 to 125°C.

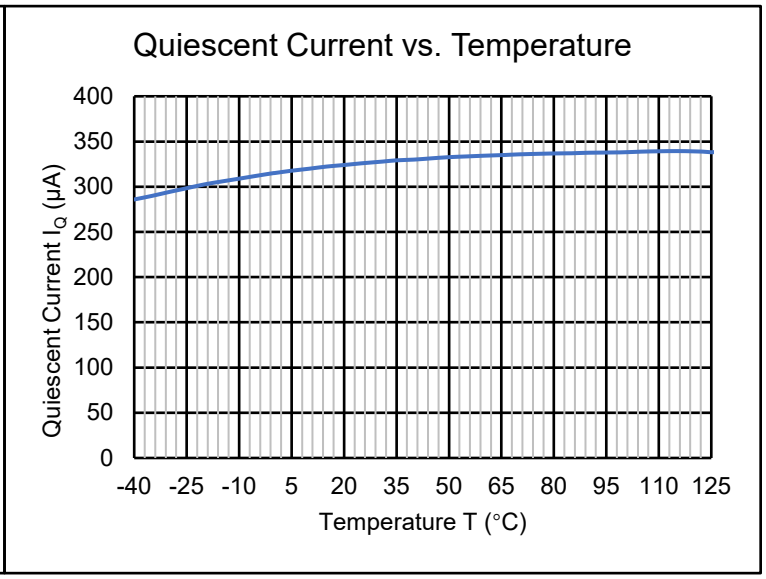
7.6 Typical Characteristics

LM358E, LM2904E (V_S = (V+) - (V-) = 5.0V, V_{CM} = 0V, R_L = ∞, T_A = 25°C, unless otherwise specified)







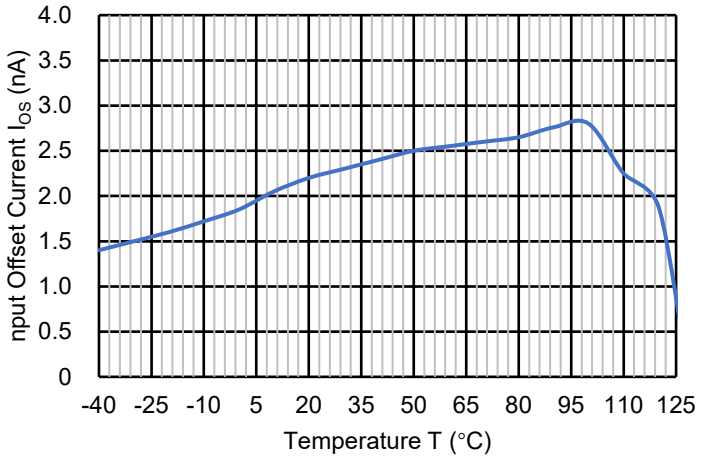


7 Specifications

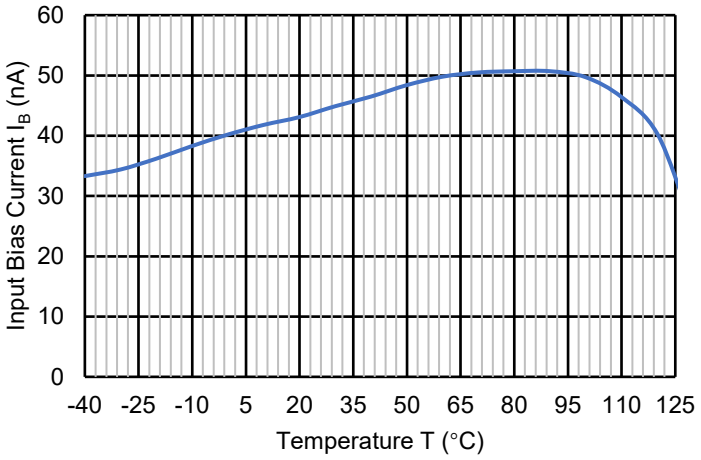
7.6 Typical Characteristics (continued)

LM358E, LM2904E (V_S = (V+) - (V-) = 5.0V, V_{CM} = 0V, R_L = ∞, T_A = 25°C, unless otherwise specified)

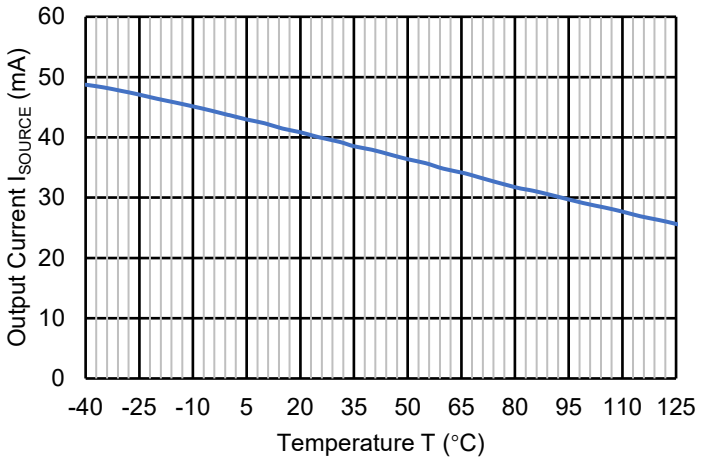
Input Offset Current vs. Temperature



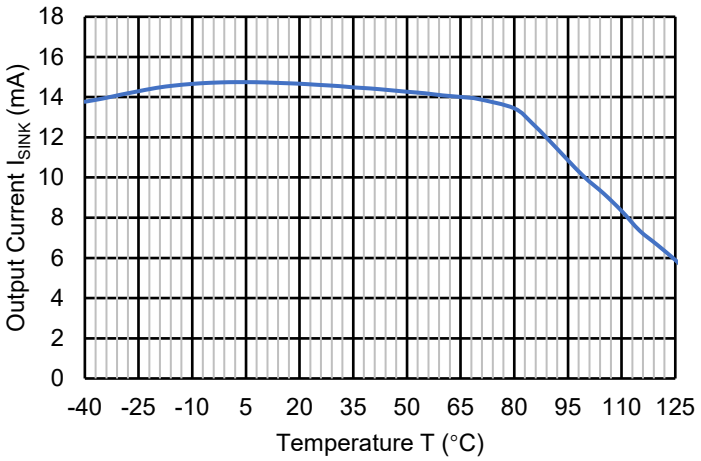
Input Bias Current vs. Temperature



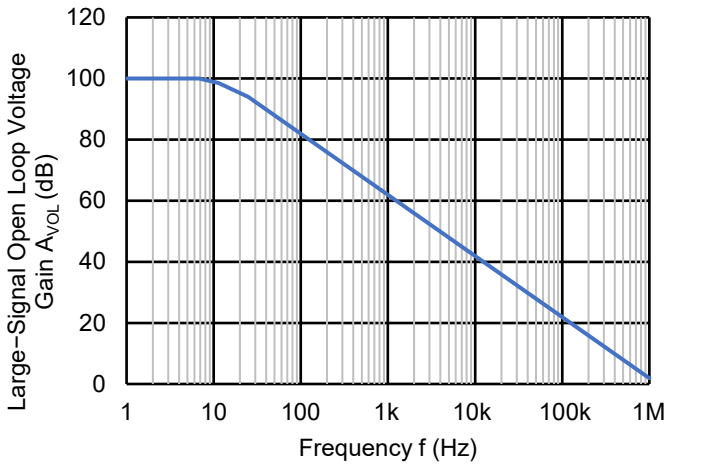
Sourcing Current vs. Temperature



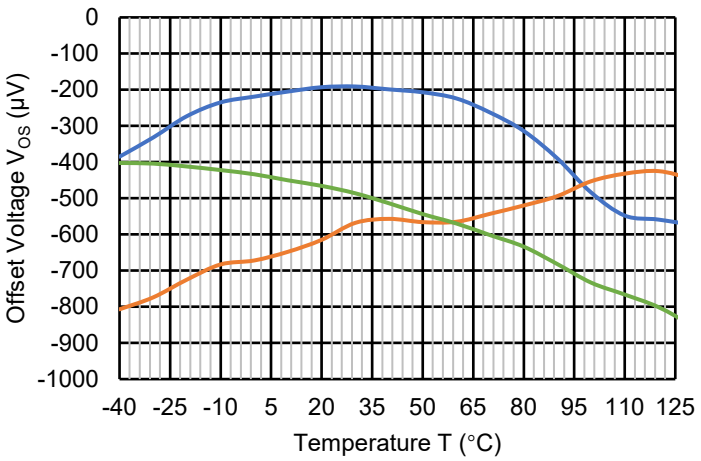
Sinking Current vs. Temperature



Large−Signal Open Loop Voltage Gain



Offset Voltage vs. Temperature

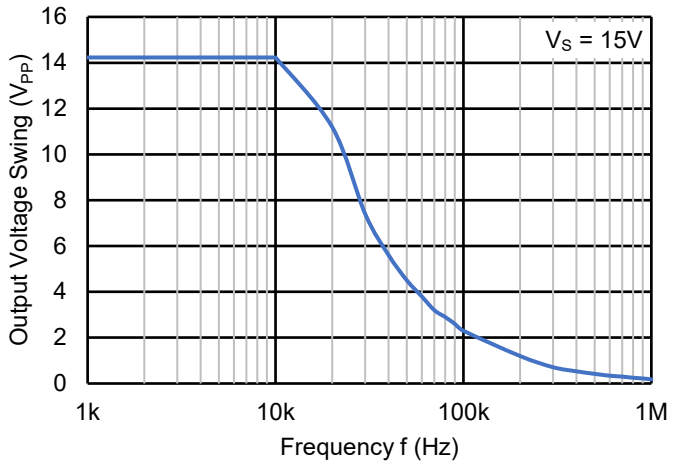


7 Specifications

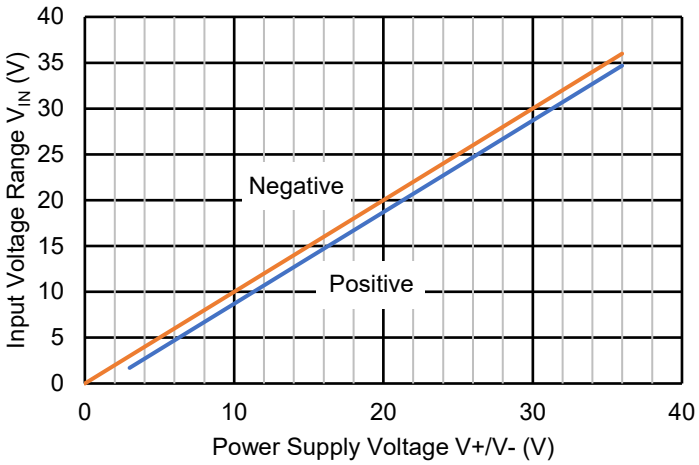
7.6 Typical Characteristics (continued)

LM358E, LM2904E (V_S = (V+) - (V-) = 5.0V, V_{CM} = 0V, R_L = ∞, T_A = 25°C, unless otherwise specified)

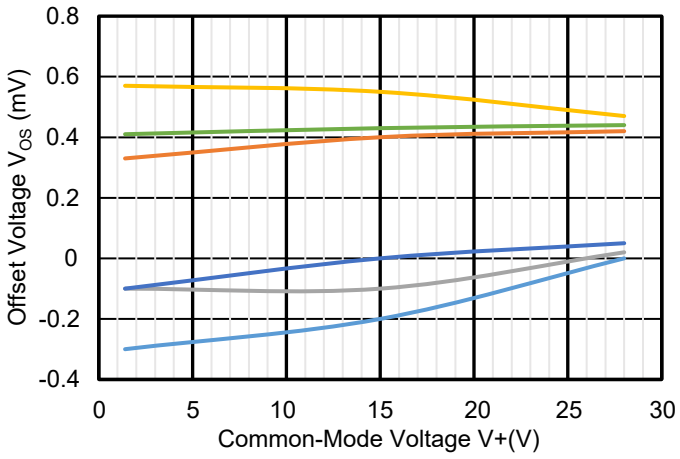
Maximum Output Swing vs. Frequency



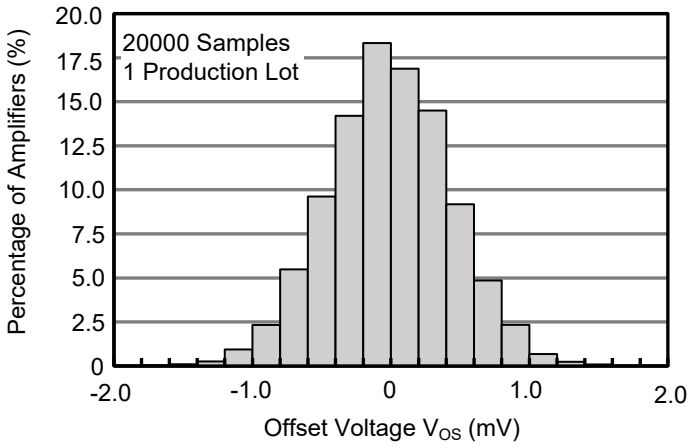
Input Voltage Range



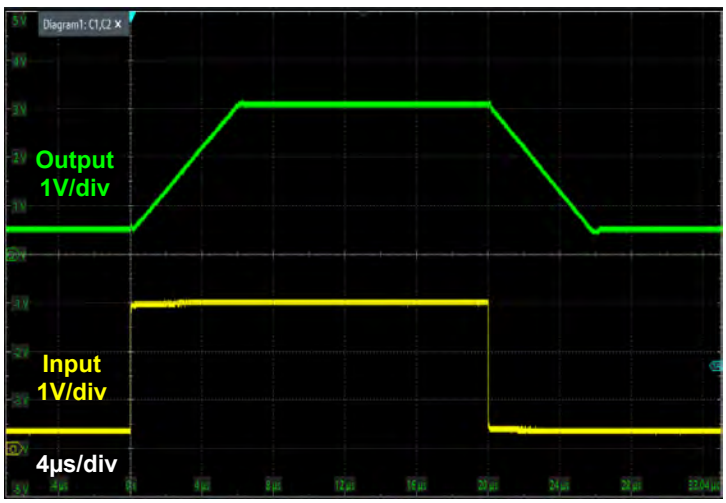
Offset Voltage vs. Common-Mode Voltage



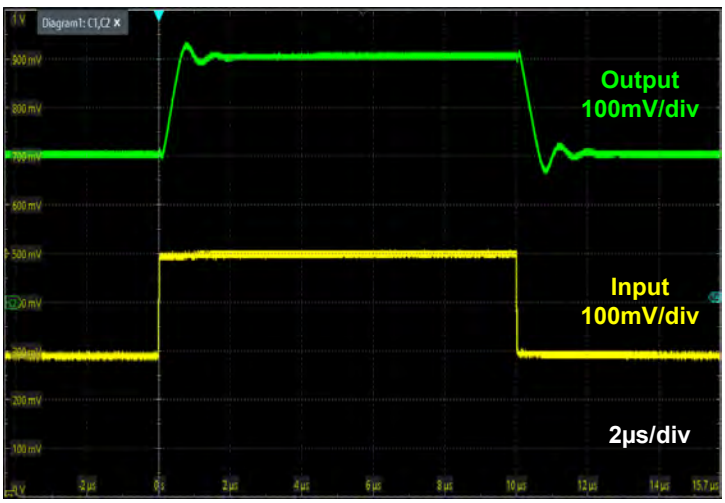
Offset Voltage Production Distribution



Large-Signal Step Response (V_S = 15V)



Small-Signal Step Response (V_S = 15V)

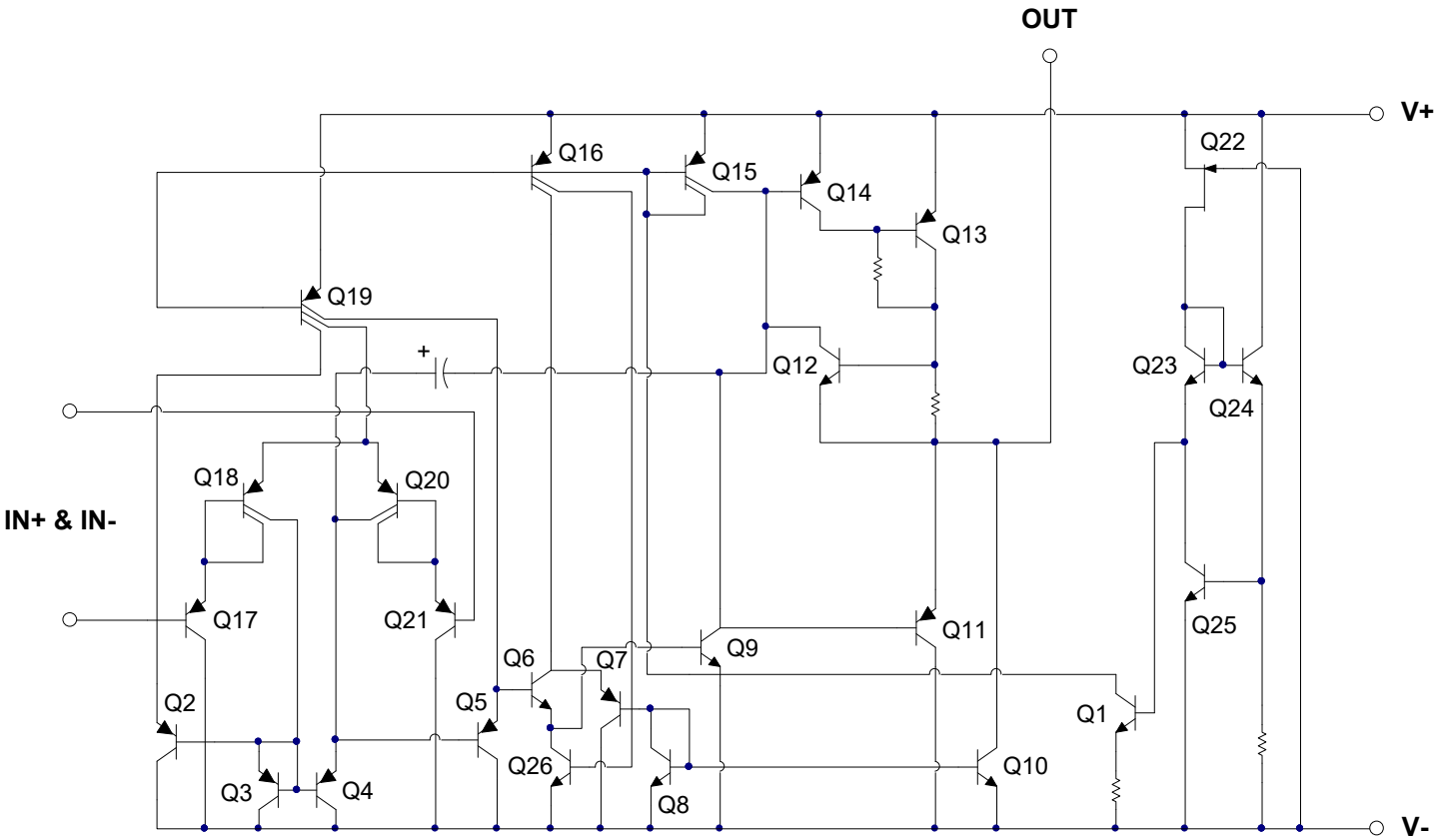


8 Detail Description

8.1 Description

The LM358E and LM2904E consist of two high gain, low-power consumption operational amplifiers, which can be powered by either a single power supply or a dual power supply. The V_S should be at least 1.5V higher than the input common mode voltage. The low power supply current is independent of the power supply voltage. The LM358E and the LM2904E can be directly powered from a standard 5V power supply used in digital systems without the need for an additional ± 5V power supply.

8.2 Representative Schematic Diagram



(One-half of Circuit Shown)

9 Application and Implementation

9.1 Typical Application Circuits

The LM358E and LM2904E are composed of two independent high gain operational amplifiers and support the use of single or dual power supplies. The maximum supply voltage V_S can reach 32V and it has low power consumption current. Therefore, they are widely used in various operational amplifier circuits.

Basic Circuit

Figure 9-1 shows a typical application of the amplifier, where a positive voltage V_{IN} is input from IN and then output from OUT after passing through the circuit. The output voltage V_{OUT} of OUT has the opposite polarity to V_{IN}. At this point, the ratio of output voltage to input voltage is the gain A_V. Their relationship is shown by the following equation:

$$\frac{V_{IN}}{R_I} = \frac{-V_{OUT}}{R_F}$$

$$A_V = \frac{V_{OUT}}{V_{IN}} = -\frac{R_F}{R_I}$$

Once the required gain for circuit design is determined, a value can be selected for R_I and R_F based on the above formula. It is recommended to use a kilo-ohm level resistor to reduce the current consumed by the device in circuit use.

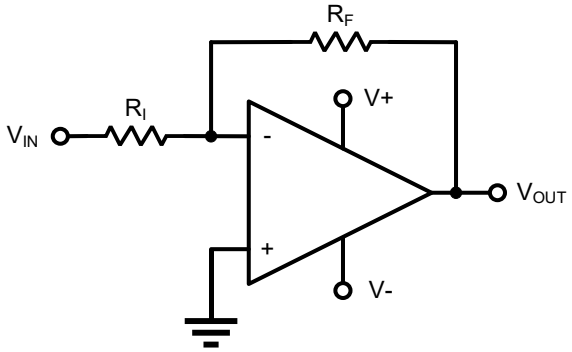


Figure 9-1. Basic Circuit

Power Supply

The LM358E and LM2904E can be powered by either a single power supply or a dual power supply, as shown in Figures 9-2 and 9-3. It is recommended to use a 0.1μF bypass capacitor and place it near the power pin to reduce noise or errors in high impedance power coupling. For more information, please refer to *Layout Guidelines*.

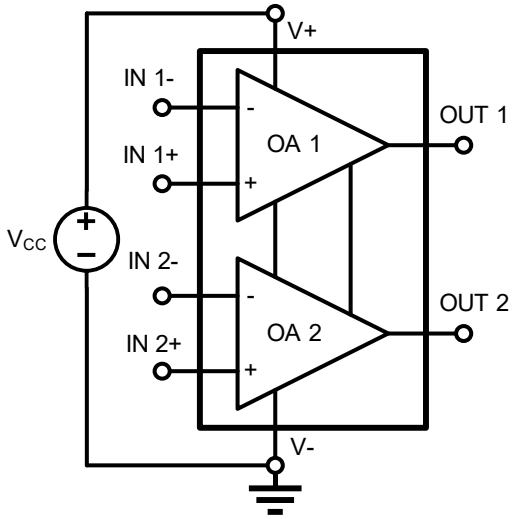


Figure 9-2. Single Power Supply

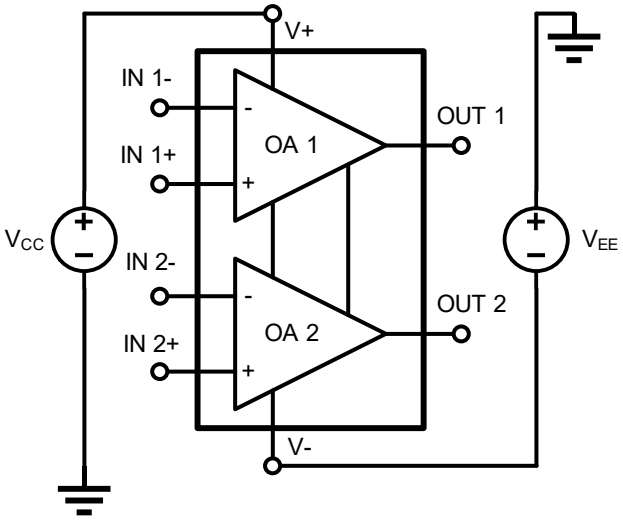
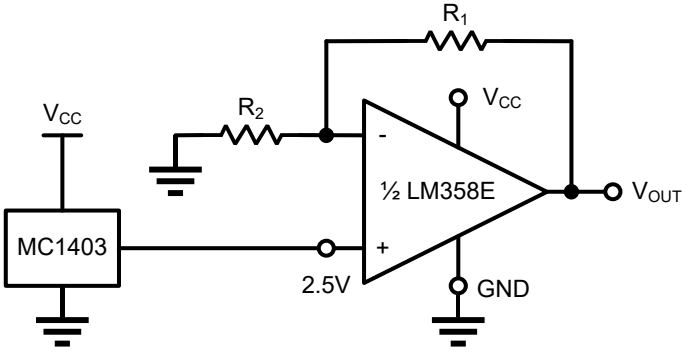


Figure 9-3. Dual Power Supply

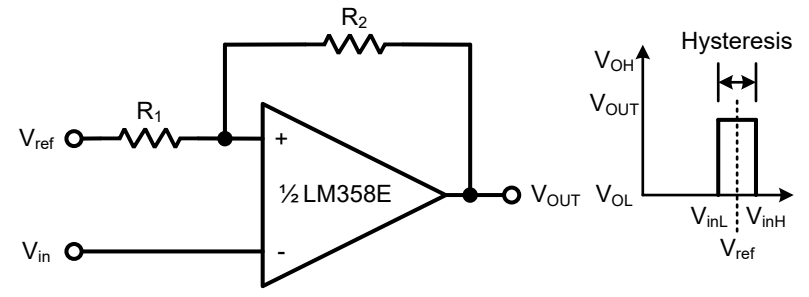
9 Application and Implementation

9.1 Typical Application Circuits (continued)



$$V_{OUT} = 2.5V \times (1 + \frac{R_1}{R_2})$$

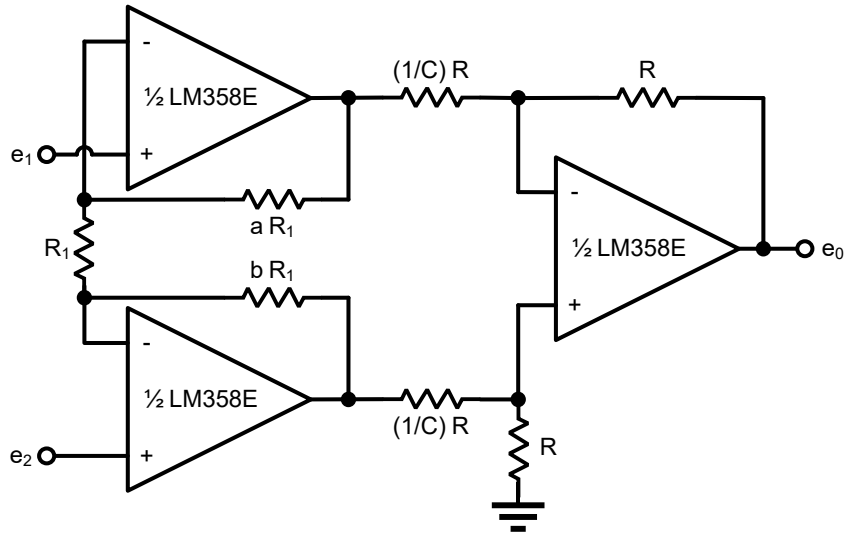
Figure 9-4. Voltage Reference



$$V_{inL} = \frac{R_1}{R_1 + R_2} \times (V_{OL} - V_{ref}) + V_{ref} \qquad V_{inH} = \frac{R_1}{R_1 + R_2} \times (V_{OH} - V_{ref}) + V_{ref}$$

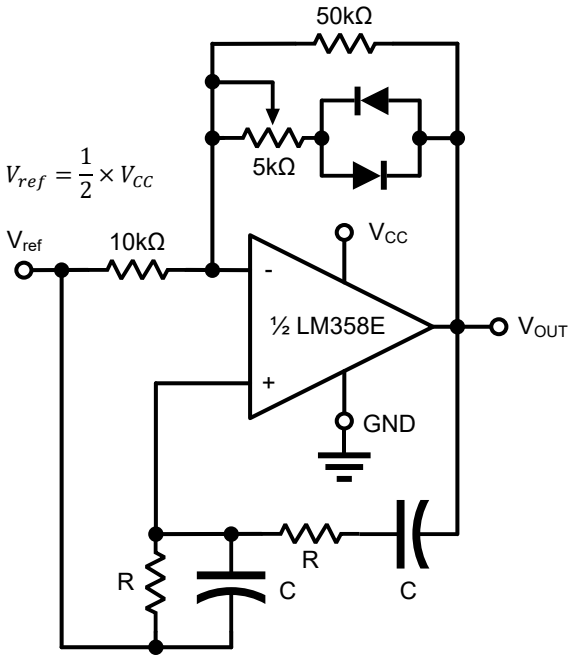
$$H = \frac{R_1}{R_1 + R_2} \times (V_{OH} - V_{OL})$$

Figure 9-5. Comparator with Hysteresis



$$e_0 = C \times (1 + a + b) \times (e_2 - e_1)$$

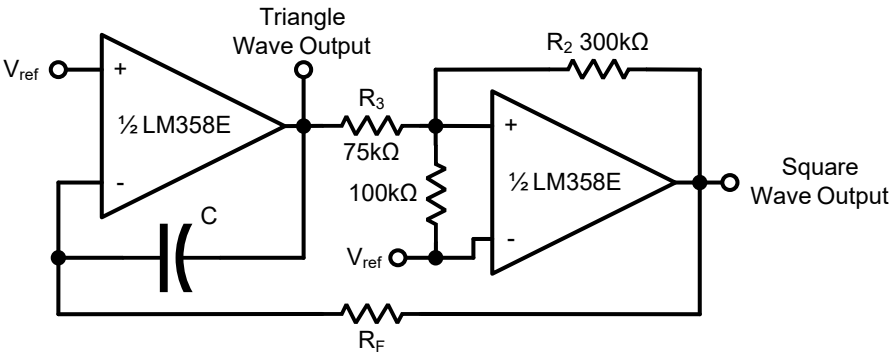
Figure 9-6. High Impedance Differential Amplifier



$$f_{OUT} = \frac{1}{2\pi RC}$$

For f_{OUT} = 1kHz, R = 16kΩ, C = 0.01μF

Figure 9-8. Wien Bridge Oscillator

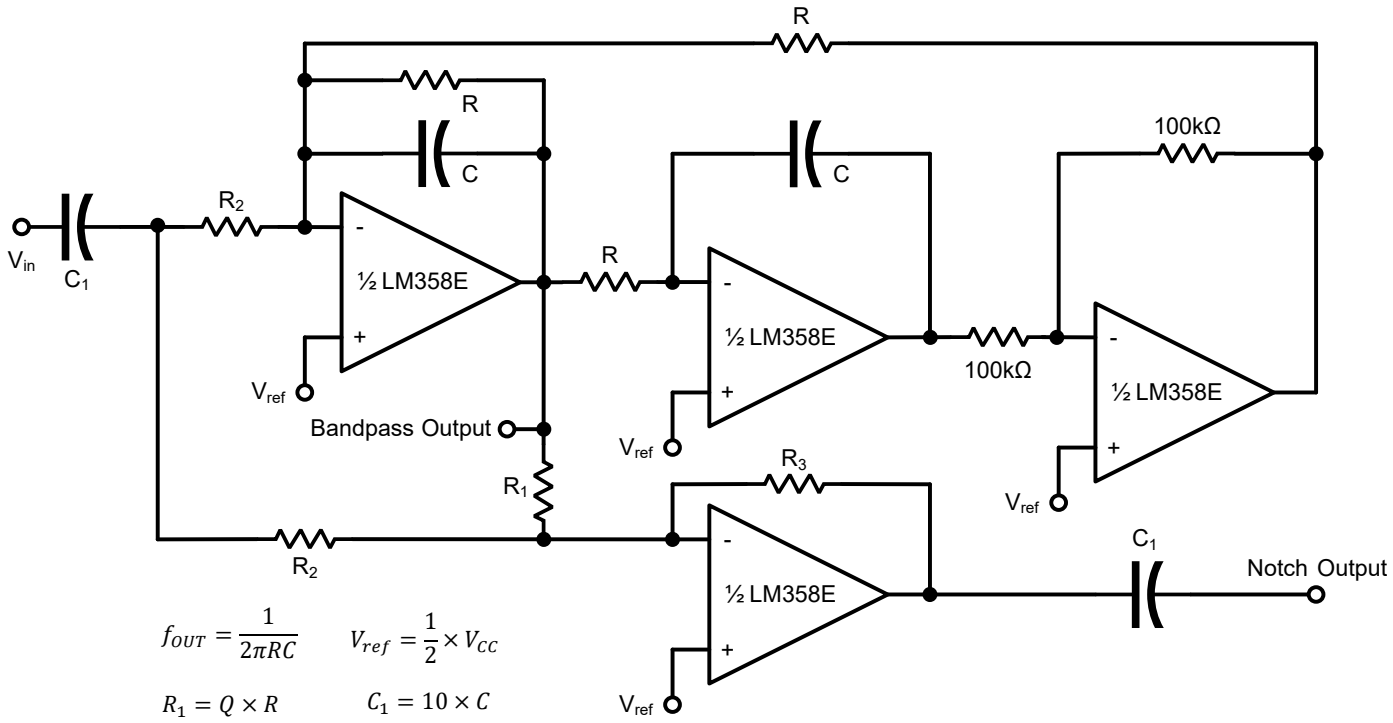


$$f = \frac{R_1 + R_C}{4 \times C \times R_F \times R_1} \quad \text{if } R_3 = \frac{R_2 \times R_1}{R_2 + R_1}$$

Figure 9-7. Function Generator

9 Application and Implementation

9.1 Typical Application Circuits (continued)



$f_{OUT} = \frac{1}{2\pi RC}$ $V_{ref} = \frac{1}{2} \times V_{CC}$

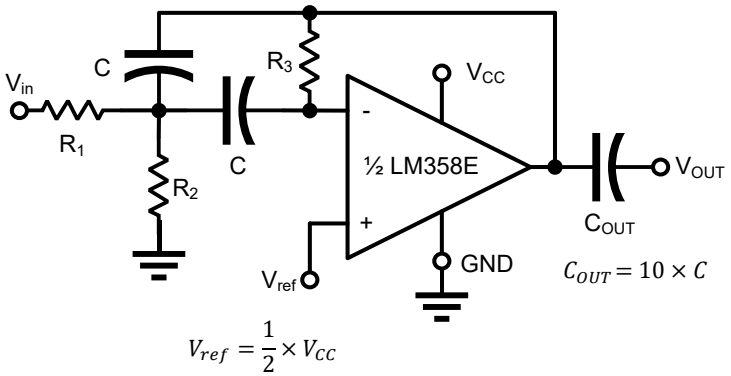
$R_1 = Q \times R$ $C_1 = 10 \times C$

$R_2 = \frac{R_1}{T_{BP}}$

$R_3 = T_N \times R_2$

For f_{OUT} = 1kHz, Q = 10, T_{BP} = 1, T_N = 1
R = 160kΩ, C = 0.001μF, R_1 = 1.6MΩ, R_2 = 1.6MΩ, R_3 = 1.6MΩ
Where T_{BP} = Center Frequency Gain, T_N = Passband Notch Gain

Figure 9-9. Bi-Quad Filter



$V_{ref} = \frac{1}{2} \times V_{CC}$

$C_{OUT} = 10 \times C$

Given: f_{OUT} = Center Frequency
$A(f_{OUT})$ = Gain at Center Frequency
Choose value f_{OUT}, C, then:

$$R_3 = \frac{Q}{\pi \times f_{OUT} \times C} \quad R_1 = \frac{R_3}{2 \times A(F_{OUT})} \quad R_2 = \frac{R_1 \times R_3}{4 \times Q^2 \times R_1 + R_3}$$

For less than 10% error from operational amplifier.

$$\frac{Q_{OUT} \times f_{OUT}}{BW} < 0.1$$

Where f_{OUT} and BW are expressed in HZ.
If source impedance varies, filter may be preceded with voltage follower buffer to stabilize filter parameters.

Figure 9-10. Multiple Feedback Bandpass Filter

9 Application and Implementation

9.2 Layout Guidelines

The LM358E and the LM2904E are widely used in various operational amplifier circuits. The following points should be taken in circuit design and PCB layout to help devices obtain the best operating performance:

1. Signal transmission traces should be as far away as possible from power supply traces to reduce parasitic coupling. It is recommended that signal traces be kept at least 5mm away from power supply lines. If the layout of the circuit does not allow this, it is better to lay out these traces vertically to avoid being parallel to each other as much as possible;
2. The length of the power supply traces should be as short as possible and bypass the power supply appropriately so as to reduce the power disturbance caused by current changes, such as when driving an AC signal to a heavy load;
3. It is recommended to use a bypass capacitor between each power supply pin (single power supply is V+, dual power supply is V+ and V-) and ground to reduce coupling noise transmitted through the power supply pins and operational amplifiers to the entire circuit. It is recommended to use ceramic bypass capacitors with low ESR and 0.1μF, and ensure that they are placed as close as possible to the corresponding pins of the device;
4. External components should be placed as close as possible to the device, and keeping RI and RF close to the input can minimize parasitic capacitance.
5. Analog grounding and digital grounding should be physically separated. Grounding the analog and digital parts of the circuit separately is a very simple but effective method for suppressing noise. When designing and laying out a multi-layer PCB circuit, one or more layers can be dedicated to a grounding layer, which can reduce EMI noise and help distribute appropriate heat on the circuit board;
6. Make sure the surface of the printed circuit board is clean and moisture-free. Use a surface coating to prevent moisture accumulation and help reduce parasitic resistance on the printed circuit board. Consider setting a low impedance guard ring (as shown in Figure 9-11) for the driver around the critical trace. The guard ring can significantly reduce the leakage current of nearby traces at different potentials.

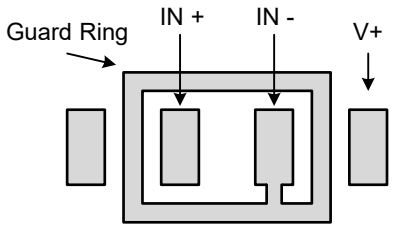
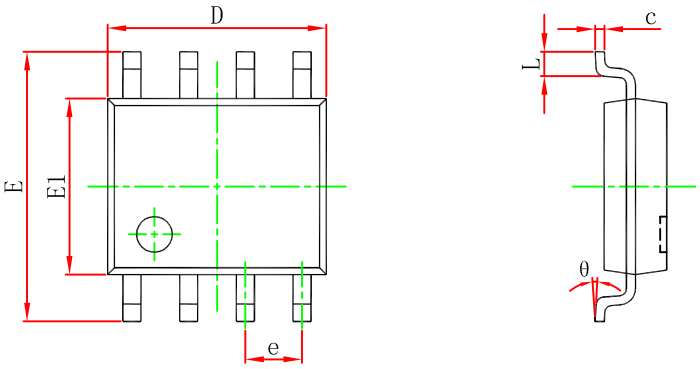


Figure 9-11. Guard Ring

10 Mechanical Information

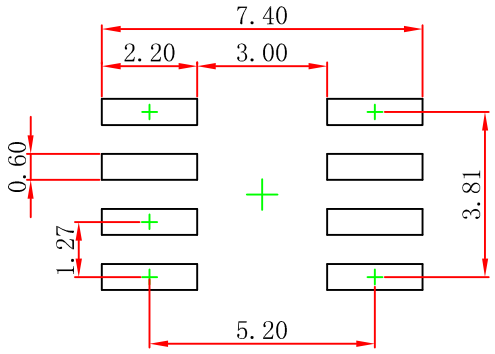
10.1 SOP8 Mechanical Information

Outline Dimensions



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	**Max**	**Min**	**Max**
A	1.450	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	0.007	0.010
D	4.700	5.100	0.185	0.201
e	1.270（BSC）		0.050（BSC）	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

SOP8 Suggest Pad Layout



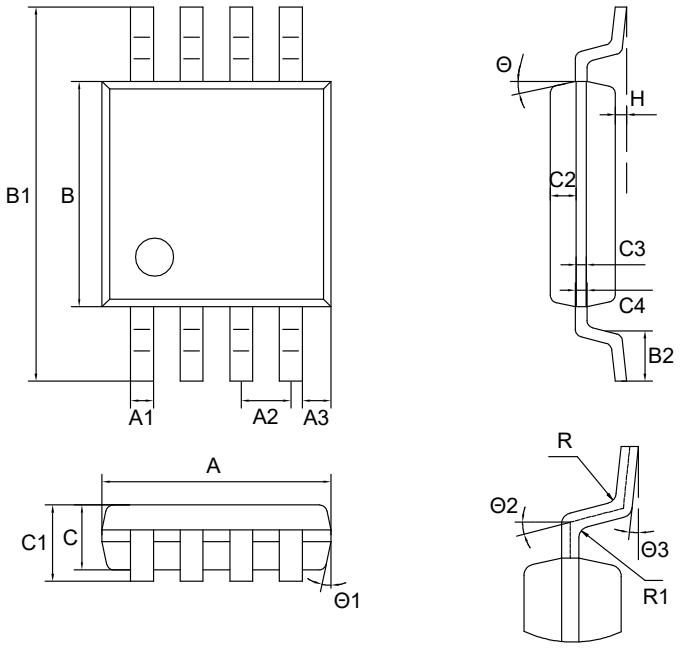
NOTE:

1. Controlling dimension: in millimeters.
2. General tolerance: ±0.05mm.
3. The pad layout is for reference purposes only.

10 Mechanical Information

10.2 MSOP8 Mechanical Information

Outline Dimensions

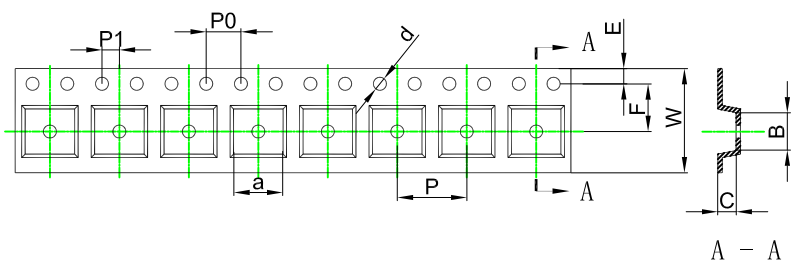


SYMBOL	DISMENSIONS IN MILLIMETERS			DISMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	2.900	3.000	3.100	0.114	0.118	0.122
A1	0.280	-	0.350	0.011	-	0.014
A2	0.650 TYP.			0.026 TYP.		
A3	0.375 TYP.			0.015 TYP.		
B	2.900	3.000	3.100	0.114	0.118	0.122
B1	4.700	-	5.100	0.185	-	0.201
B2	0.450	0.600	0.750	0.018	0.024	0.030
C	0.750	0.850	0.950	0.030	0.033	0.037
C1	-	-	1.100	-	-	0.043
C2	0.328 TYP.			0.013 TYP.		
C3	0.152 TYP.			0.006 TYP.		
C4	0.150	-	0.230	0.006	-	0.009
H	0.000	-	0.090	0.000	-	0.004
Θ	-	12°	-	-	12°	-
Θ1	-	12°	-	-	12°	-
Θ2	-	14°	-	-	14°	-
Θ3	0°	-	6°	0°	-	6°
R	0.150 TYP.			0.006 TYP.		
R1	0.150 TYP.			0.006 TYP.		

11 Packaging Information

SOP8 Tape and Reel Information

Embossed Carrier Tape



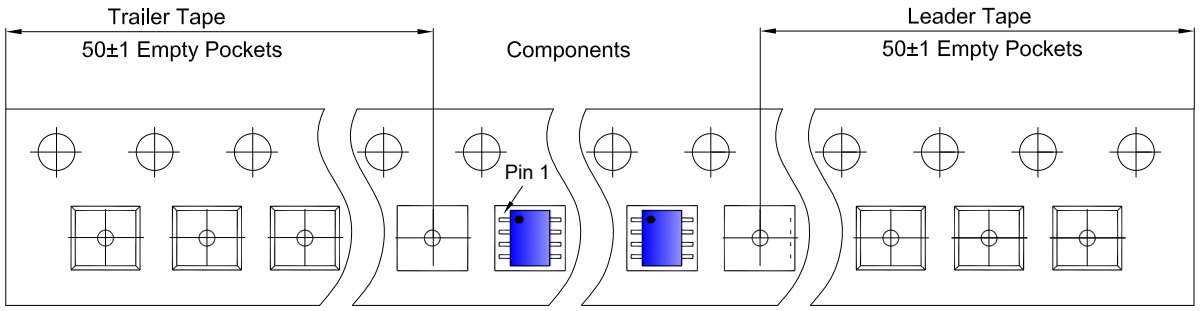
Packaging Description:

SOP8 parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts in standard option are shipped with 2,500 units per 13" or 33cm diameter reel. The reels are clear in color and is made of polystyrene plastic (anti-static coated).

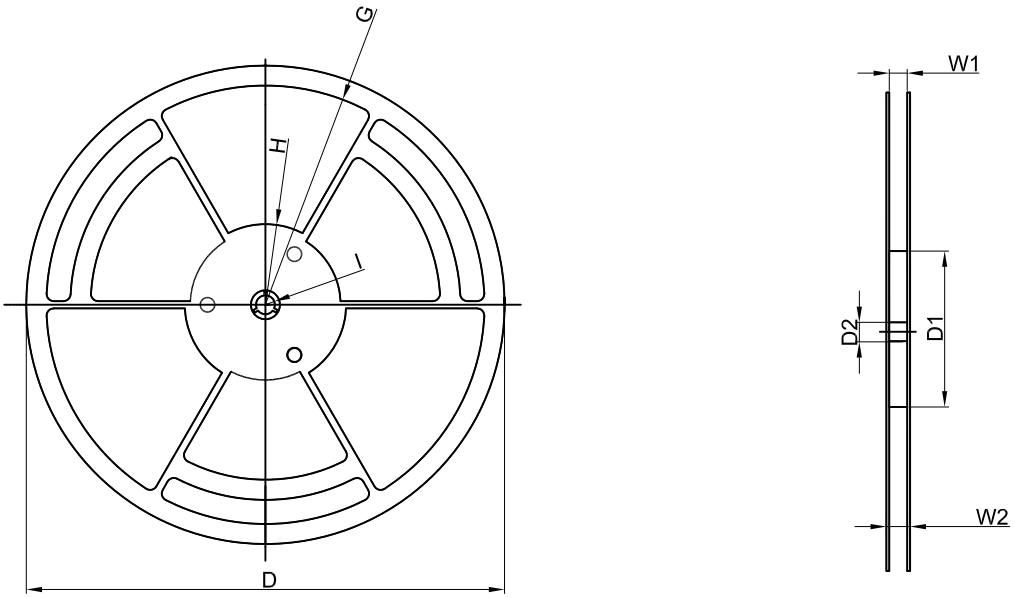
ALL DIM IN mm

Dimensions are in millimeter										
Pkg type	a	B	C	d	E	F	P0	P	P1	W
SOP8	6.40	5.40	2.10	Ø1.50	1.75	5.50	4.00	8.00	2.00	12.00

Tape Leader and Trailer



Reel



Dimensions are in millimeter								
Reel Option	D	D1	D2	G	H	I	W1	W2
13"Dia	Ø330.00	100.00	13.00	R151.00	R56.00	R6.50	12.40	17.60

REEL	Reel Size	Box	Box Size(mm)	Carton	Carton Size(mm)	G.W.(kg)
4,000 pcs	13 inch	8,000 pcs	360×360×65	64,000 pcs	565×380×390	

12 Notes and Revision History

12.1 Associated Product Family and Others

To view other products of the same type or IC products of other types, click the official website of SZCJ -- https: ***www.***szcjsemi.com for more details.

12.2 Notes

Electrostatic Discharge Caution



This IC may be damaged by ESD. Relevant personnel shall comply with correct installation and use specifications to avoid ESD damage to the IC. If appropriate measures are not taken to prevent ESD damage, the hazards caused by ESD include but are not limited to degradation of integrated circuit performance or complete damage of integrated circuit. For some precision integrated circuits, a very small parameter change may cause the whole device to be inconsistent with its published specifications.

12.3 Revision History

April 2024: released LM358E, LM2904E rev - 1.0.

DISCLAIMER

IMPORTANT NOTICE, PLEASE READ CAREFULLY

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Any person who purchases or uses SZCJ products for design shall: 1. Select products suitable for circuit application and design; 2. Design, verify and test the rationality of circuit design; 3. Procedures to ensure that the design complies with relevant laws and regulations and the requirements of such laws and regulations. SZCJ makes no warranty or representation as to the accuracy or completeness of the information contained in this data sheet and assumes no responsibility for the application or use of any of the products described in this data sheet.

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