

LM258, LM358, LM358A, LM2904, LM2904A, LM2904V, NCV2904

Single Supply Dual Operational Amplifiers

Utilizing the circuit designs perfected for Quad Operational Amplifiers, these dual operational amplifiers feature low power drain, a common mode input voltage range extending to ground/ V_{EE} , and single supply or split supply operation. The LM358 series is equivalent to one-half of an LM324.

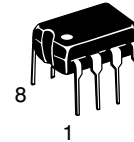
These amplifiers have several distinct advantages over standard operational amplifier types in single supply applications. They can operate at supply voltages as low as 3.0 V or as high as 32 V, with quiescent currents about one-fifth of those associated with the MC1741 (on a per amplifier basis). The common mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications. The output voltage range also includes the negative power supply voltage.

Features

- Short Circuit Protected Outputs
- True Differential Input Stage
- Single Supply Operation: 3.0 V to 32 V
- Low Input Bias Currents
- Internally Compensated
- Common Mode Range Extends to Negative Supply
- Single and Split Supply Operation
- ESD Clamps on the Inputs Increase Ruggedness of the Device without Affecting Operation
- Pb-Free Packages are Available
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes



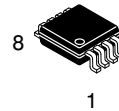
ON Semiconductor®



PDIP-8
N, AN, VN SUFFIX
CASE 626

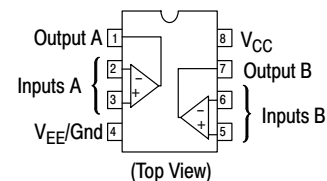


SOIC-8
D, VD SUFFIX
CASE 751



Micro8™
DMR2 SUFFIX
CASE 846A

PIN CONNECTIONS



ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 11 of this data sheet.

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MAXIMUM RATINGS ($T_A = +25^\circ\text{C}$, unless otherwise noted.)

Rating	Symbol	Value	Unit
Power Supply Voltages Single Supply Split Supplies	V_{CC} V_{CC}, V_{EE}	32 ± 16	Vdc
Input Differential Voltage Range (Note 1)	V_{IDR}	± 32	Vdc
Input Common Mode Voltage Range (Note 2)	V_{ICR}	-0.3 to 32	Vdc
Output Short Circuit Duration	t_{SC}	Continuous	
Junction Temperature	T_J	150	$^\circ\text{C}$
Thermal Resistance, Junction-to-Air (Note 3)	Case 846A Case 751 Case 626	$R_{\theta JA}$ 238 212 161	$^\circ\text{C}/\text{W}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
ESD Protection at any Pin Human Body Model Machine Model	V_{esd}	2000 200	V
Operating Ambient Temperature Range	T_A	LM258 LM358, LM358A LM2904/LM2904A LM2904V, NCV2904 (Note 4) -25 to +85 0 to +70 -40 to +105 -40 to +125	$^\circ\text{C}$

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Split Power Supplies.
2. For supply voltages less than 32 V the absolute maximum input voltage is equal to the supply voltage.
3. All $R_{\theta JA}$ measurements made on evaluation board with 1 oz. copper traces of minimum pad size. All device outputs were active.
4. *NCV2904 is qualified for automotive use.*

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ELECTRICAL CHARACTERISTICS ($V_{CC} = 5.0\text{ V}$, $V_{EE} = \text{GND}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.)

Characteristic	Symbol	LM258			LM358			LM358A			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage $V_{CC} = 5.0\text{ V}$ to 30 V , $V_{IC} = 0\text{ V}$ to $V_{CC} - 1.7\text{ V}$, $V_O \approx 1.4\text{ V}$, $R_S = 0\ \Omega$ $T_A = 25^\circ\text{C}$ $T_A = T_{\text{high}}$ (Note 5) $T_A = T_{\text{low}}$ (Note 5)	V_{IO}	-	2.0	5.0	-	2.0	7.0	-	2.0	3.0	mV
Average Temperature Coefficient of Input Offset Voltage $T_A = T_{\text{high}}$ to T_{low} (Note 5)	$\Delta V_{IO}/\Delta T$	-	7.0	-	-	7.0	-	-	7.0	-	$\mu\text{V}/^\circ\text{C}$
Input Offset Current $T_A = T_{\text{high}}$ to T_{low} (Note 5)	I_{IO}	-	3.0	30	-	5.0	50	-	5.0	30	nA
Input Bias Current $T_A = T_{\text{high}}$ to T_{low} (Note 5)	I_{IB}	-	-45	-150	-	-45	-250	-	-45	-100	nA
Average Temperature Coefficient of Input Offset Current $T_A = T_{\text{high}}$ to T_{low} (Note 5)	$\Delta I_{IO}/\Delta T$	-	10	-	-	10	-	-	10	-	$\text{pA}/^\circ\text{C}$
Input Common Mode Voltage Range (Note 6), $V_{CC} = 30\text{ V}$ $V_{CC} = 30\text{ V}$, $T_A = T_{\text{high}}$ to T_{low}	V_{ICR}	0	-	28.3	0	-	28.3	0	-	28.5	V
Differential Input Voltage Range	V_{IDR}	-	-	V_{CC}	-	-	V_{CC}	-	-	V_{CC}	V
Large Signal Open Loop Voltage Gain $R_L = 2.0\text{ k}\Omega$, $V_{CC} = 15\text{ V}$, For Large V_O Swing, $T_A = T_{\text{high}}$ to T_{low} (Note 5)	A_{VOL}	50	100	-	25	100	-	25	100	-	V/mV
Channel Separation $1.0\text{ kHz} \leq f \leq 20\text{ kHz}$, Input Referenced	CS	-	-120	-	-	-120	-	-	-120	-	dB
Common Mode Rejection $R_S \leq 10\text{ k}\Omega$	CMR	70	85	-	65	70	-	65	70	-	dB
Power Supply Rejection	PSR	65	100	-	65	100	-	65	100	-	dB
Output Voltage-High Limit $T_A = T_{\text{high}}$ to T_{low} (Note 5) $V_{CC} = 5.0\text{ V}$, $R_L = 2.0\text{ k}\Omega$, $T_A = 25^\circ\text{C}$ $V_{CC} = 30\text{ V}$, $R_L = 2.0\text{ k}\Omega$ $V_{CC} = 30\text{ V}$, $R_L = 10\text{ k}\Omega$	V_{OH}	3.3	3.5	-	3.3	3.5	-	3.3	3.5	-	V
Output Voltage-Low Limit $V_{CC} = 5.0\text{ V}$, $R_L = 10\text{ k}\Omega$, $T_A = T_{\text{high}}$ to T_{low} (Note 5)	V_{OL}	-	5.0	20	-	5.0	20	-	5.0	20	mV
Output Source Current $V_{ID} = +1.0\text{ V}$, $V_{CC} = 15\text{ V}$ $T_A = T_{\text{high}}$ to T_{low} (LM358A Only)	I_{O+}	20	40	-	20	40	-	20	40	-	mA
Output Sink Current $V_{ID} = -1.0\text{ V}$, $V_{CC} = 15\text{ V}$ $T_A = T_{\text{high}}$ to T_{low} (LM358A Only) $V_{ID} = -1.0\text{ V}$, $V_O = 200\text{ mV}$	I_{O-}	10	20	-	10	20	-	10	20	-	mA
Output Short Circuit to Ground (Note 7)	I_{SC}	-	40	60	-	40	60	-	40	60	mA
Power Supply Current (Total Device) $T_A = T_{\text{high}}$ to T_{low} (Note 5) $V_{CC} = 30\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$ $V_{CC} = 5\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$	I_{CC}	-	1.5	3.0	-	1.5	3.0	-	1.5	2.0	mA

5. LM258: $T_{\text{low}} = -25^\circ\text{C}$, $T_{\text{high}} = +85^\circ\text{C}$

LM2904/LM2904A: $T_{\text{low}} = -40^\circ\text{C}$, $T_{\text{high}} = +105^\circ\text{C}$

NCV2904 is qualified for automotive use.

LM358, LM358A: $T_{\text{low}} = 0^\circ\text{C}$, $T_{\text{high}} = +70^\circ\text{C}$

LM2904V & NCV2904: $T_{\text{low}} = -40^\circ\text{C}$, $T_{\text{high}} = +125^\circ\text{C}$

6. The input common mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common mode voltage range is $V_{CC} - 1.7\text{ V}$.

7. Short circuits from the output to V_{CC} can cause excessive heating and eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.

LM258, LM358, LM358A, LM2904, LM2904A, LM2904V, NCV2904

ELECTRICAL CHARACTERISTICS ($V_{CC} = 5.0\text{ V}$, $V_{EE} = \text{Gnd}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.)

Characteristic	Symbol	LM2904			LM2904A			LM2904V, NCV2904			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage $V_{CC} = 5.0\text{ V}$ to 30 V , $V_{IC} = 0\text{ V}$ to $V_{CC} - 1.7\text{ V}$, $V_O \approx 1.4\text{ V}$, $R_S = 0\ \Omega$ $T_A = 25^\circ\text{C}$ $T_A = T_{\text{high}}$ (Note 8) $T_A = T_{\text{low}}$ (Note 8)	V_{IO}	-	2.0	7.0	-	2.0	7.0	-	-	7.0	mV
Average Temperature Coefficient of Input Offset Voltage $T_A = T_{\text{high}}$ to T_{low} (Note 8)	$\Delta V_{IO}/\Delta T$	-	7.0	-	-	7.0	-	-	7.0	-	$\mu\text{V}/^\circ\text{C}$
Input Offset Current $T_A = T_{\text{high}}$ to T_{low} (Note 8)	I_{IO}	-	5.0	50	-	5.0	50	-	5.0	50	nA
Input Bias Current $T_A = T_{\text{high}}$ to T_{low} (Note 8)	I_{IB}	-	-45	-250	-	-45	-100	-	-45	-250	nA
Average Temperature Coefficient of Input Offset Current $T_A = T_{\text{high}}$ to T_{low} (Note 8)	$\Delta I_{IO}/\Delta T$	-	10	-	-	10	-	-	10	-	$\text{pA}/^\circ\text{C}$
Input Common Mode Voltage Range (Note 9), $V_{CC} = 30\text{ V}$ $V_{CC} = 30\text{ V}$, $T_A = T_{\text{high}}$ to T_{low}	V_{ICR}	0	-	24.3	0	-	24.3	0	-	24.3	V
Differential Input Voltage Range	V_{IDR}	-	-	V_{CC}	-	-	V_{CC}	-	-	V_{CC}	V
Large Signal Open Loop Voltage Gain $R_L = 2.0\text{ k}\Omega$, $V_{CC} = 15\text{ V}$, For Large V_O Swing, $T_A = T_{\text{high}}$ to T_{low} (Note 8)	A_{VOL}	25 15	100 -	- -	25 15	100 -	- -	25 15	100 -	- -	V/mV
Channel Separation $1.0\text{ kHz} \leq f \leq 20\text{ kHz}$, Input Referenced	CS	-	-120	-	-	-120	-	-	-120	-	dB
Common Mode Rejection $R_S \leq 10\text{ k}\Omega$	CMR	50	70	-	50	70	-	50	70	-	dB
Power Supply Rejection	PSR	50	100	-	50	100	-	50	100	-	dB
Output Voltage-High Limit $T_A = T_{\text{high}}$ to T_{low} (Note 8) $V_{CC} = 5.0\text{ V}$, $R_L = 2.0\text{ k}\Omega$, $T_A = 25^\circ\text{C}$ $V_{CC} = 30\text{ V}$, $R_L = 2.0\text{ k}\Omega$ $V_{CC} = 30\text{ V}$, $R_L = 10\text{ k}\Omega$	V_{OH}	3.3 22 23	3.5 - 24	- - -	3.3 22 23	3.5 - 24	- - -	3.3 22 23	3.5 - 24	- - -	V
Output Voltage-Low Limit $V_{CC} = 5.0\text{ V}$, $R_L = 10\text{ k}\Omega$, $T_A = T_{\text{high}}$ to T_{low} (Note 8)	V_{OL}	-	5.0	20	-	5.0	20	-	5.0	20	mV
Output Source Current $V_{ID} = +1.0\text{ V}$, $V_{CC} = 15\text{ V}$	I_{O+}	20	40	-	20	40	-	20	40	-	mA
Output Sink Current $V_{ID} = -1.0\text{ V}$, $V_{CC} = 15\text{ V}$ $V_{ID} = -1.0\text{ V}$, $V_O = 200\text{ mV}$	I_{O-}	10 -	20 -	- -	10 -	20 -	- -	10 -	20 -	- -	mA μA
Output Short Circuit to Ground (Note 10)	I_{SC}	-	40	60	-	40	60	-	40	60	mA
Power Supply Current (Total Device) $T_A = T_{\text{high}}$ to T_{low} (Note 8) $V_{CC} = 30\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$ $V_{CC} = 5\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$	I_{CC}	-	1.5 0.7	3.0 1.2	-	1.5 0.7	3.0 1.2	-	1.5 0.7	3.0 1.2	mA

8. LM258: $T_{\text{low}} = -25^\circ\text{C}$, $T_{\text{high}} = +85^\circ\text{C}$

LM2904/LM2904A: $T_{\text{low}} = -40^\circ\text{C}$, $T_{\text{high}} = +105^\circ\text{C}$

NCV2904 is qualified for automotive use.

LM358, LM358A: $T_{\text{low}} = 0^\circ\text{C}$, $T_{\text{high}} = +70^\circ\text{C}$

LM2904V & NCV2904: $T_{\text{low}} = -40^\circ\text{C}$, $T_{\text{high}} = +125^\circ\text{C}$

9. The input common mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common mode voltage range is $V_{CC} - 1.7\text{ V}$.

10. Short circuits from the output to V_{CC} can cause excessive heating and eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.

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ORDERING INFORMATION

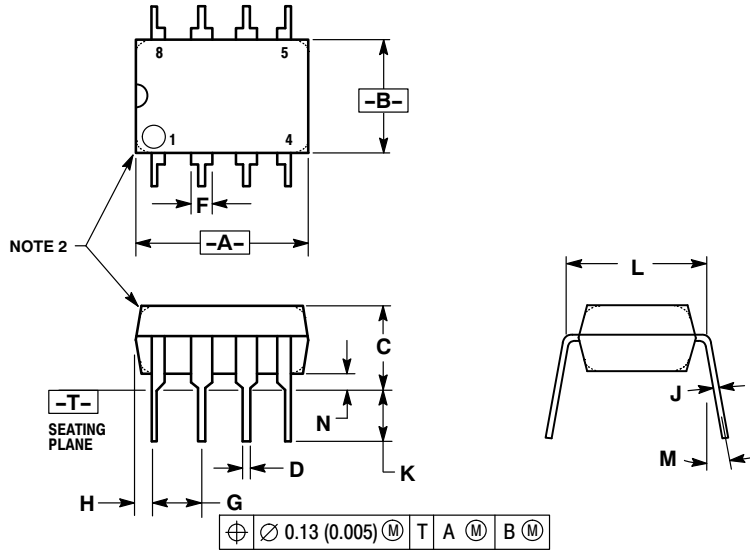
Device	Operating Temperature Range	Package	Shipping [†]	
LM358ADR2G	0°C to +70°C	SOIC-8 (Pb-Free)	2500 Tape & Reel	
LM358D		SOIC-8	98 Units/Rail	
LM358DG		SOIC-8 (Pb-Free)	98 Units/Rail	
LM358DR2		SOIC-8	2500 Tape & Reel	
LM358DR2G		SOIC-8 (Pb-Free)	2500 Tape & Reel	
LM358DMR2		Micro8	4000 Tape & Reel	
LM358DMR2G		Micro8 (Pb-Free)	4000 Tape & Reel	
LM358N		PDIP-8	50 Units/Rail	
LM358NG		PDIP-8 (Pb-Free)	50 Units/Rail	
LM258D		-25°C to +85°C	SOIC-8	98 Units/Rail
LM258DG	SOIC-8 (Pb-Free)		98 Units/Rail	
LM258DR2	SOIC-8		2500 Tape & Reel	
LM258DR2G	SOIC-8 (Pb-Free)		2500 Tape & Reel	
LM258DMR2	Micro8		4000 Tape & Reel	
LM258DMR2G	Micro8 (Pb-Free)		4000 Tape & Reel	
LM258N	PDIP-8		50 Units/Rail	
LM258NG	PDIP-8 (Pb-Free)		50 Units/Rail	
LM2904D	-40°C to +105°C		SOIC-8	98 Units/Rail
LM2904DG			SOIC-8 (Pb-Free)	98 Units/Rail
LM2904DR2		SOIC-8	2500 Tape & Reel	
LM2904DR2G		SOIC-8 (Pb-Free)	2500 Tape & Reel	
LM2904DMR2		Micro8	2500 Tape & Reel	
LM2904DMR2G		Micro8 (Pb-Free)	2500 Tape & Reel	
LM2904N		PDIP-8	50 Units/Rail	
LM2904NG		PDIP-8 (Pb-Free)	50 Units/Rail	
LM2904ADMG		Micro8 (Pb-Free)	4000 Tape & Reel	
LM2904ADMR2		Micro8	4000 Tape & Reel	
LM2904ADMR2G		Micro8 (Pb-Free)	4000 Tape & Reel	
LM2904AN		PDIP-8	50 Units/Rail	
LM2904ANG		PDIP-8 (Pb-Free)	50 Units/Rail	

[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

LM258, LM358, LM358A, LM2904, LM2904A, LM2904V, NCV2904

PACKAGE DIMENSIONS

PDIP-8
 N, AN, VN SUFFIX
 CASE 626-05
 ISSUE L



NOTES:

1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	10.16	0.370	0.400
B	6.10	6.60	0.240	0.260
C	3.94	4.45	0.155	0.175
D	0.38	0.51	0.015	0.020
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	0.76	1.27	0.030	0.050
J	0.20	0.30	0.008	0.012
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	---	10°	---	10°
N	0.76	1.01	0.030	0.040