

**LM158, LM258, LM358
LM258A, LM358A, LM2904
DUAL OPERATIONAL AMPLIFIERS**

D2231, JUNE 1978—REVISED AUGUST 1988

- **Wide Range of Supply Voltages:**
Single Supply . . . 3 V to 30 V
(LM2904 . . . 3 V to 26 V),
or Dual Supplies
- **Low Supply Current Drain Independent of Supply Voltage . . . 0.7 mA Typ**
- **Common-Mode Input Voltage Range**
Includes Ground Allowing Direct Sensing near Ground
- **Low Input Bias and Offset Parameters:**
Input Offset Voltage . . . 3 mV Typ
A Versions . . . 2 mV Typ
Input Offset Current . . . 2 nA Typ
Input Bias Current . . . 20 nA Typ
A Versions . . . 15 nA Typ
- **Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage . . . ±32 V**
(±26 V for LM2904)
- **Open-Loop Differential Voltage Amplification . . . 100 V/mV Typ**
- **Internal Frequency Compensation**

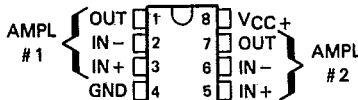
description

These devices consist of two independent, high-gain, frequency-compensated operational amplifiers that were designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies is also possible so long as the difference between the two supplies is 3 V to 30 V (3 V to 26 V for the LM2904), and the VCC pin 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.

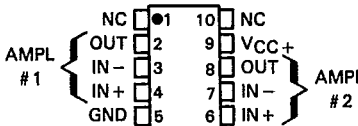
Applications include transducer amplifiers, d-c amplification blocks, and all the conventional operational amplifier circuits that now can be more easily implemented in single-supply-voltage systems. For example, these devices can be operated directly off of the standard 5-V supply that is used in digital systems and will easily provide the required interface electronics without requiring additional ±15-V supplies.

The LM158 is characterized for operation over the full military temperature range of -55°C to 125°C. The LM258 and LM258A are characterized for operation from -25°C to 85°C, the LM358 and LM358A from 0°C to 70°C, and the LM2904 from -40°C to 105°C.

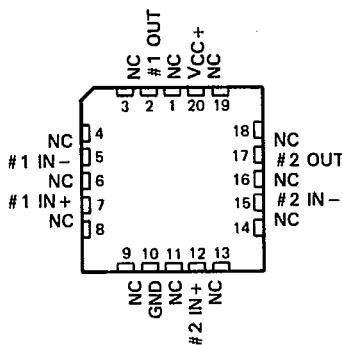
D, JG, OR P PACKAGE T-79-05-20
(TOP VIEW)



U FLAT PACKAGE
(TOP VIEW)

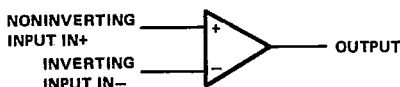


LM 158
FK CHIP CARRIER PACKAGE
(TOP VIEW)



NC—No internal connection

schematic (each amplifier)



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Operational Amplifiers

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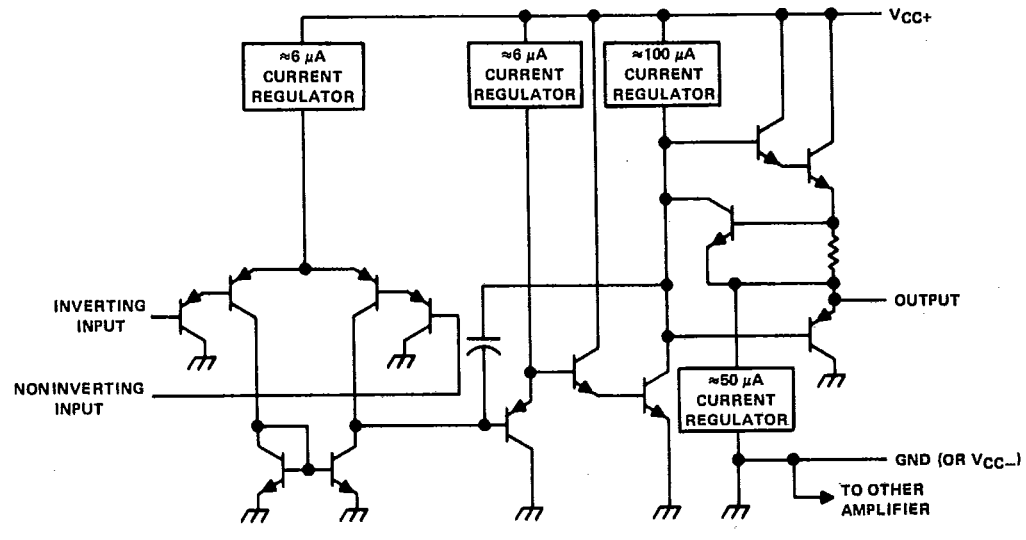
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AVAILABLE OPTIONS

T _A	V _{IO} MAX AT 25°C	PACKAGE				
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	FLAT PACK (U)
0°C to 70°C	7 mV	LM358D	-	LM358JG	LM358P	-
-25°C to 85°C	3 mV	LM358AD	-	LM358AJG	LM358AP	-
-40°C to 105°C	5 mV	LM258D	-	LM258JG	LM258P	-
-55°C to 125°C	3 mV	LM258AD	-	LM258AJG	LM258AP	-
-55°C to 125°C	7 mV	LM2904D	-	LM2904JG	LM2904P	-
-55°C to 125°C	5 mV	-	LM158FK	LM158JG	-	LM158U

The D package is available taped and reeled. Add the suffix R to the device type. (e.g., LM358DR)

schematic (each amplifier)



2 Operational Amplifiers

**LM158, LM258, LM358, LM258A, LM358A, LM2904
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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

		LM158, LM258, LM258A LM358, LM358A	LM2904	UNIT	
Supply voltage, V_{CC} (see Note 1)		32	26	V	
Differential voltage (see Note 2)		± 32	± 26	V	
Input voltage range (either input)		0.3 to 32	0.3 to 26	V	
Duration of output short-circuit (one amplifier) to ground at (or below) 25°C free-air temperature ($V_{CC} \leq 15$ V) (see Note 3)		unlimited	unlimited		
Continuous total dissipation		See Dissipation Rating Table			
Operating free-air temperature range	LM158	-55 to 125		°C	
	LM258, LM258A	-25 to 85			
	LM358, LM358A	0 to 70			
	LM2904		-40 to 105		
Storage temperature range		-65 to 150	-65 to 150	°C	
Case temperature for 60 seconds		FK package	260	°C	
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds		JG, or U package	300	300	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds		D or P package	260	260	°C

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Operational Amplifiers

- NOTES: 1. All voltage values, except differential voltages, and V_{CC} specified for measurement of I_{OS} , are with respect to the network ground terminal.
 2. Differential voltages are at the noninverting input terminal with respect to the inverting input terminal.
 3. Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D	725 mW	5.8 mW/°C	464 mW	377 mW	—
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
JG (LM158)	1060 mW	8.4 mW/°C	672 mW	546 mW	210 mW
JG (all others)	825 mW	6.6 mW/°C	528 mW	429 mW	—
P	1000 mW	8.0 mW/°C	640 mW	520 mW	—
U	675 mW	5.4 mW/°C	432 mW	351 mW	135 mW

LM158, LM258, LM358, LM2904
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2 Operational Amplifiers

electrical characteristics at specified free-air temperature, VCC = 5 V (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	LM158, LM258			LM358			LM2904			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO} Input offset voltage	VCC = 5 V to MAX, V _{IC} = V _{ICR} min, V _O = 1.4 V	25°C	3	5	3	7	3	7	3	7	mV
		Full range	7	7	9	10					
α _{V_{IO}} Average temperature coefficient of input offset voltage	Full range	25°C	7	7	7	7	7	7	7	7	μV/°C
		Full range	2	30	50	2	50	2	50		
I _{IO} Input offset current	V _O = 1.4 V	25°C	2	30	2	50	2	50	2	50	nA
		Full range	100	150	200						
e _{II_O} Average temperature coefficient of input offset current	Full range	25°C	10	10	10	10	10	10	10	10	pA/°C
		Full range	-20	-150	-250	-20	-250	-20	-250		
I _{IB} Input bias current	V _O = 1.4 V	25°C	-20	-150	-20	-250	-20	-250	-20	-250	nA
		Full range	-300	-500							
V _{ICR} Common-mode input voltage range	VCC = 5 V to MAX	25°C	0 to VCC-1.5	0 to VCC-1.5	0 to VCC-1.5	0 to VCC-1.5	0 to VCC-1.5	0 to VCC-1.5	0 to VCC-1.5	0 to VCC-1.5	V
		Full range	0 to VCC-2	0 to VCC-2	0 to VCC-2	0 to VCC-2	0 to VCC-2	0 to VCC-2	0 to VCC-2		
		25°C	VCC-1.5	VCC-1.5	VCC-1.5	VCC-1.5	VCC-1.5	VCC-1.5	VCC-1.5		
		25°C	26	26	26	26	26	26	26		
V _{OH} High-level output voltage	VCC = MAX, R _L = 2 kΩ	25°C	27	28	27	28	27	28	27	28	V
		Full range	27	28	27	28	27	28	27	28	
		25°C	27	28	27	28	27	28	27	28	
		Full range	23	24							
V _{OL} Low-level output voltage	R _L ≤ 10 kΩ	25°C	5	20	5	20	5	20	5	20	mV
		Full range	5	20	5	20	5	20	5	20	

Parameter	Conditions	Temperature			Units
		25°C	50	100	
AVD Large-signal differential voltage amplification	VCC = 15 V, VO = 1 V to 11 V, RL = ≥ 2 kΩ	25°C	25	100	100
		Full range	15		15
CMRR Common-mode rejection ratio	VCC = 5 V to MAX, VIC = VICR min	25°C	65	80	80
		Full range	50		50
KSVR Supply voltage rejection ratio (ΔVCC/ΔVIO)	VCC = 5 V to MAX	25°C	65	100	100
		Full range	50		50
V _{01/02} Crosstalk attenuation	f = 1 kHz to 20 kHz	25°C	120	120	120
		Full range	-20	-30	-20 -30
IO Output current	VCC = 15 V, VID = -1 V, VO = 0	25°C	-10		-10
		Full range	-10		-10
		25°C	10	20	10 20
		Full range	5	5	5
IOS Short-circuit output current	VCC at 5 V, GND at -5 V, VO = 0	25°C	12	30	30
		Full range	±40	±60	±40 ±60
ICC Supply current (two amplifiers)	VO = 2.5 V, No load VCC = MAX, VO = 0.5 VCC, No load	25°C	0.7	1.2	0.7 1.2
		Full range	1	2	1 2

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. "MAX" VCC for testing purposes is 26 V for LM2904, 30 V for the others. Full range is -55°C to 125°C for LM158, -25°C to 85°C for LM258, 0°C to 70°C for LM358, and -40°C to 105°C for LM2904.

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Operational Amplifiers



LM258A, LM358A
DUAL OPERATIONAL AMPLIFIERS

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2 Operational Amplifiers

electrical characteristics at specified free-air temperature, VCC = 5 V (unless otherwise noted)

PARAMETER	TEST CONDITIONS ¹	LM258A			LM358A			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO}	V _{CC} = 5 V to 30 V V _{IC} = V _{ICR} min, V _O = 1.4 V	2	3	3	2	3	mV	
αV _{IO}	Full range		4			5		
I _{IO}	Full range	7	15		7	20	μA/°C	
	V _O = 1.4 V	2	15	30	2	30	nA	
	Full range					75		
αI _{IO}	Full range	10	200		10	300	pA/°C	
I _{IB}	Full range	-15	-80	-100	-15	-100	nA	
	V _O = 1.4 V					-200		
	Full range	0 to			0 to			
	25°C	V _{CC} = 1.5			V _{CC} = 1.5		V	
V _{ICR}	V _{CC} 30 V	0 to			0 to			
	Common-mode input	V _{CC} = 2			V _{CC} = 2			
	voltage range	V _{CC} = 1.5			V _{CC} = 1.5			
	R _L ≥ 2 kΩ	26			26		V	
	V _{CC} = 30 V, R _L = 2 kΩ							
V _{OH}	High-level output voltage	27	28	28	27	28		
	V _{CC} = 30 V, R _L ≥ 10 kΩ							
V _{OL}	Low-level output voltage	5	20	20	5	20	mV	
	R _L ≤ 10 kΩ							

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		25°C	50 100		25 100		V/mV
			Full range		15		
A/D	Large-signal differential voltage amplification	25°C	25		65 80		dB
			Full range		65 100		
CMRR	Common-mode rejection ratio	25°C	70 80		120		dB
kSVR	Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	25°C	65 100		10		
V_{O1}/V_{O2}	Crosstalk attenuation	25°C	10 20		5		mA
I_O	Output current	25°C	12 30		±40 ±60		
I_{OS}	Short-circuit output current	25°C	0.7 1.2		0.7 1.2		mA
I_{CC}	Supply current (two amplifiers)	Full range	1 2		2		

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Full range is -25°C to 85°C for LM258A and 0°C to 70°C to LM358A.

Operational Amplifiers **2**