

National Semiconductor Corporation

LM158/LM258/LM358, LM158A/LM258A/LM358A, LM2904 Low Power Dual Operational Amplifiers

General Description

The LM158 series consists of two independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, dc gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply systems. For example, the LM158 series can be directly operated off of the standard +5 V_{DC} power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional ±15 V_{DC} power supplies.

Unique Characteristics

- In the linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.
- The unity gain cross frequency is temperature compensated.
- The input bias current is also temperature compensated.

Advantages

- Eliminates need for dual supplies
- Two internally compensated op amps in a single package

- Allows directly sensing near GND and VOUT also goes to GND Compatible with all forms of logic
- Power drain suitable for battery operation
- Pin-out same as LM1558/LM1458 dual operational amplifier

Features

- Internally frequency compensated for unity gain
- Large dc voltage gain
- 100 dB Wide bandwidth (unity gain) 1 MHz (temperature compensated)
- Wide power supply range: Single supply 3 V_{DC} to 32 V_{DC} ±1.5 V_{DC} to ±16 V_{DC} or dual supplies
- Very low supply current drain (500 µA)-essentially independent of supply voltage (1 mW/op amp at +5 Vnc)
- Low input biasing current 45 nA_{DC} (temperature compensated)
- Low input offset voltage 2 mV_{DC} and offset current 5 nA_{DC}
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- 0 Vpc to V⁺ 1.5 Vpc Large output voltage swing



AUSOIULE IVIS If Military/Aerospa (Note 9)	ace specified devic	ngs es are required	, contact th	e National S	Semicond	uctor Sales	Office/D	istributors	for avai	ability anc	l specific	cations.		
	LM15 LM158A	8/LM258/LM35 //LM258A/LM3	8 58A LI	M2904				_	LM158/ M158A/I	LM258/LM M258A/LI	1358 1358A	LM2904		
Supply Voltage, V+ Differential Input Vo Input Voltage	32 V Itage –0.3	/ _{DC} or ± 16 V _{DC} 32 V _{DC} V _{DC} to +32 V _{DC}	26 V _{DC} 2 0.3 V _D	or ±13 V _{DC} 6 V _{DC} c to +26 V _D	U	Operating LM358 LM258 LM258 LM158	Temperatu	ire Range	0°C - 25°-	to +70°C C to +85° C to +125°	ا د د	40°C to +6	35°C	
Power Dissipation (F Molded DIP (LM3: Metal Can (LM156	Vote 1) 58N) 8H/	830 mW	8	30 mW		Storage Te Lead Temp	mperature	Range	- 65°	C to + 150°	Γ Ο	65°C to +1	50°C	
LM258H/LM358F Small Outline Pac	1) :kage	550 mW 530 mW	5	30 mW		(Solderin ESD rating	ig, 10 seco to be dete	nds) DIP rmined.		260°C		260°C		
Output Short-Circuit (One Amplifier) (N	to GND lote 2)		Ċ			Lead Temp (Solderin	berature ig, 10 secc	(spu		300°C		300°C		
V T S 15 VDC and Input Current (V _{IN} < (Note 3)	$1 = 25^{\circ}$ C	Continuous 50 mA	5	0 mA		Soldering I Dual-In-L Solder	Information Ine Packa Ing (10 sec	ge conds)		260°C		260°C		
						Vapor Vapor Infrare	Phase (60 d) (15 seco	age seconds) nds)		215°C 220°C		215°C 220°C		
						See AN-45 Reliability"	0 "Surface for other r	Mounting	Methods soldering	and Their E surface mo	ffect on F unt devic	Product ies.		0.10.0101
Electrical Ch	haracteristic	S V+ = +5.0	/DC, T _A = 25	s°C, unless o	therwise s	tated								
Parameter	Conditions		LM158A	LM2	258A	LM35	84	LM158/L	M258	LM3	28	LM29	904	Units
		Min	Typ Max	Min Typ	Мах	Min Typ	Мах	Min Typ	Мах	Min Typ	Мах	Min Typ	Max	
Input Offset Voltage	(Note 5)		±1 ±2	+1	+3	±2	土3	±2	±5	±2	±7	±2	±7	mV _{DC}
Input Bias Current	$l_{IN(+)}$ or $l_{IN(-)}$, V _{CM} = 0V, (Note 6)		20 50	40	80	45	100	45	150	45	250	45	250	nAbc
Input Offset Current	$l_{IN(+)} - l_{IN(-)}$, Vcm	V0 = V	±2 ±10	+2	土15	±5	±30	±3	±30	±5	±50	±5	±50	nApc
Input Common-Mode Voltage Range	$V^+ = 30 V_{DC}$, (Note (LM2904, $V^+ = 26$)	e 7) 0 V) 0	V+-1.	5 0	V + - 1.5	0	V+-1.5	0	+-1.5	0	/+ -1.5	0	V + -1.5	V _{DC}
Supply Current	$R_{L} = \infty, V^{+} = 30V$ (LM2904 V ⁺ = 26V	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	1 2	+	7	-	N	-	N	-	N	-	5	mApc
	$R_L = \infty$ on all Op A Over Full Temperatu	mps ure Range	0.7 1.2	0.7	1.2	0.7	1.2	0.7	1.2	0.7	1.2	0.7	1.2	mApc
							M2904	M358A/L	58A/LI	8A/LM2	/LM15	3/LM358	/LM25	LM158

LM158/LM258/LM358/LM158A/LM258A/LM358A/LM2904

Electrical Ch	aracteristics (Continued)	= + 1	+ 5.0 V _{DC}	Note	4, unles:	s other	wise s	tated										
Parameter	Conditions	Ξ	M158A		LM258A		5	A358A	-	LM15	8/LM258		LM358			LM290	4	Ilnite
		Min	Typ Max	Min	Typ	Мах	Min	Typ N	ax M	in T	yp Max	Min	Typ	Max	Min	Typ	Max	61110
Large Signal Voltage Gain	$\begin{array}{l} V^{+}=15V_{DC}\\ R_{L}\geq2k\Omega,(ForV_{O}=1V_{DC}\\ to11V_{DC})\end{array}$	50	100	50	100		25	100	2	0	00	25	100		25	100		V/m/V
Common-Mode Rejection Ratio	DC, $V_{CM} = 0V \text{ to } V^+ - 1.5 V_{DC}$	70	85	20	85		65	85	2	0	22	65	02		50		70	岛
Power Supply Rejection Ratio	DC, V ⁺ = 5 V _{DC} to 30 V _{DC} (LM2904, V ⁺ = 5 V _{DC} to 26 V _{DC}), T _A = 25°C	65	100	65	100		65	100	6	5	8	65	100		50	100		鸱
Amplifier-to-Amplifier Coupling	$f = 1 \text{ kHz}$ to 20 kHz, $T_A = 25^{\circ}\text{C}$ (Input Referred), (Note 8)		-120		-120			-120		1	120		- 120			-120		đb
Output Current Source	$V_{IN}^{1} = 1 V_{DC},$ $V_{IN}^{-} = 0 V_{DC},$ $V^{+} = 15 V_{DC},$ $V_{O} = 2 V_{DC}, T_{A} = 25^{\circ}C$	20	40	20	40		20	40	~~~~	0	Q	20	40		20	40		mA _{DC}
Sink		10	20	10	20		10	20	-	0	Q	10	20		10	50		mApc
		12	50	12	50		12	50	-	N	0	12	50		12	50		μADC
Short Circuit to Ground	$T_A = 25^{\circ}C$, (Note 2), V ⁺ = 15 V _{DC}		40 60		40	60		40	0	,	09 01		40	60		40	60	mApc
Input Offset Voltage	(Note 5)		±4			±4		т	:5		±7			±9			±10	mV _{DC}
Input Offset Voltage Drift	$R_S = 0\Omega$		7 15		7	15		7 2	0		7		7			7		۵°/۷щ
Input Offset Current	$l_{IN(+)} - l_{IN(-)}$		±30			±30		+1	75		±100			±150		±45	±200	nApc
Input Offset Current Drift	$R_{S} = 0.0$		10 200		9	200		10 3	8		0		10			₽		pA _{DC} /°C
Input Bias Current	lin(+) or lin(-)		40 100		40	100		40 2	8		0 300		40	500		40	500	nApc

	Image: Non-state Image: Non-state Num Type Mun Type Mun <t< th=""><th>eter</th><th>Conditions</th><th>E</th><th>M158A</th><th>_</th><th>LM258.</th><th>A</th><th>-</th><th>M358A</th><th></th><th>M158/L</th><th>M258</th><th></th><th>LM358</th><th></th><th></th><th>M2904</th><th>- </th></t<>	eter	Conditions	E	M158A	_	LM258.	A	-	M358A		M158/L	M258		LM358			M2904	-
def $V + = 30$ V _{DC} , (Note T) 0 $V + -2$ 0 0 $V + -2$ 0 0 $V + -2$ 0 0	Odd $V + = 30$ Vpc, (Note T) 0 $V + -2$			Min T	'yp Max	Min	Typ	Мах	Min 7	ryp Ma:	K Mir	Typ	Мах	Min	Typ A	Aax N	Ain T	yp Ma	×
age V = +15 VpC 15 25 15 25 15 15 V/m/V Ming $P_{1,2} \ge 2kn$ 25 15 26 26 26 V/c V/c Ming V = +30 VpC; N1 + 28 VpC; 26 26 26 26 26 V/c V/c NMM V = +30 VpC; N1 + 28 VpC; 27 28 27 28 27 28 29 24 V/c NMM V = +170c; VM - = 0 VpC; 10 27 28 27 28 27 28 27 28 29 24 V/c V/c NM + = +170c; VM - = 0 VpC; 10 27 28 27 <td>age$V^{+} = +15 V_{DC}$1525152515151515VimMMB$R_{-2} \ge 10$ km$R_{-2} \ge 10$ km$R_{-2} \ge 10$ km$R_{-2} \ge 10$ km$R_{-2} \ge 10$ km$V_{DC}$$V_{DC} = 1 V_{DC} =$</td> <td>lode</td> <td>V+ = 30 V_{DC}, (Note 7) (LM2904, V⁺ = 26 V_{DC})</td> <td>0</td> <td>−+∨</td> <td>5</td> <td>-</td> <td>V+-2</td> <td>0</td> <td>- + V</td> <td>-2 0</td> <td></td> <td>V+-2</td> <td>0</td> <td>-></td> <td>+ - 2</td> <td>0</td> <td>+></td> <td>-2</td>	age $V^{+} = +15 V_{DC}$ 1525152515151515VimMMB $R_{-2} \ge 10$ km V_{DC} $V_{DC} = 1 V_{DC} =$	lode	V+ = 30 V _{DC} , (Note 7) (LM2904, V ⁺ = 26 V _{DC})	0	−+∨	5	-	V+-2	0	- + V	-2 0		V+-2	0	->	+ - 2	0	+>	-2
Wing $V_{1} = 300$ Vpc, $H_{1} = 2$ k/l 26 26 26 26 26 26 26 26	Wing $V = +30$ V(cc, H ₁ = 2 k/l)262626262626262627282924Vic $V + = 5$ V/cc, RL, $2 \cdot 10$ k/l)2728272827282324Vic $V + = 5$ V/cc, RL, $2 \cdot 10$ k/l)52052052052078824Vic $V + = 5$ V/cc, RL, $2 \cdot 10$ k/l)52052052052078824Vic $V + = 5$ V/cc, RL, $2 \cdot 10$ k/l)10201020102010201020 $V + = 5$ V/cc, RL, $2 \cdot 10$ k/l)102010201020102010 $V + = 5$ V/cc, RL, $2 \cdot 10$ k/l)102010201020102010 $V + = 5$ V/cc, RL, $2 \cdot 10$ k/l)102010201020102010 $V + = 5$ V/cc, RL, $2 \cdot 10$ k/l, MH = 0 V/cc1020102010201020 $V + = 5$ V/cc, RL, $2 \cdot 10$ k/l, MH = 0 V/cc1020102010201020 $V + = 5$ V/cc155858585828Right A Right A Rid A Right A Right A Right A Right A Ri	tage	$V^{+} = +15 V_{DC}$ (Vo = 1 V_{DC} to 11 V_{DC}) $R_{L} \ge 2 k\Omega$	25		25			15		25			15			15		>
$ \begin{bmatrix} \mathbf{R}_{1,2} = 10 \mathrm{KR}_{1,2} \\ \mathbf{L}_{2,2} = 10 \mathrm{KR}_{1,2} \\ \mathbf{L}_{1,2} = 5 \underline{V}_{DC}, \mathbf{R}_{1,2} = 10 \mathrm{KR}_{1,2} \\ \mathbf{L}_{1,2} = 5 \underline{V}_{DC}, \mathbf{R}_{1,2} = 10 \mathrm{KR}_{1,2} \\ \mathbf{L}_{1,2} = 5 \underline{V}_{DC}, \mathbf{R}_{1,2} = 10 \mathrm{KR}_{1,2} \\ \mathbf{L}_{1,2} = 5 \underline{V}_{DC}, \mathbf{R}_{1,2} = 10 \mathrm{KR}_{1,2} \\ \mathbf{L}_{1,2} = 5 \underline{V}_{DC}, \mathbf{R}_{1,2} = 10 \mathrm{KR}_{1,2} \\ \mathbf{L}_{1,2} = 2 \mathbf{L}_{1,2} \\ \mathbf{L}_{1,2} = 1 \mathbf{L}_{1,2}$	$ \frac{R_{12} + 10Kn}{R_{12} + 0Kn} = 28 V_{DC} + \frac{1}{5} \times 20 V_{DC} + \frac{2}{5} \times 20 V_{D} + \frac{2}{5} \times 20$	Swing	$V^+ = +30 V_{DC}, R_L = 2 k\Omega$	26		26			26		26			26			52		
$V + = 5V_{DC}$, $R_{L} \ge 10^{4}$ 5205205205205100 MDC $V0 = 2V_{DC}$ $VN + = 11V_{DC}$, $VN - = 0V_{DC}$ 102010201020 MDC $V + = 15V_{DC}$ $VN + = 11V_{DC}$, $VN + = 0V_{DC}$ 102010201020 MDC $VN = = 15V_{DC}$ 10 1020102010201020 MDC $VN = = 15V_{DC}$ 10 1020102010201020 MDC $VN = = 15V_{DC}$ 10 1558585858 $MN = = 11V_{DC}$, $VN + = 0V_{DC}$ 10 1020102010201020 $NN = = 15V_{DC}$ 10 15585858585 $MN = 15V_{DC}$ 10 1558585878 $NN = 15V_{DC}$ 10 15585878878 $NN = 15V_{DC}$ 10 10 20 10 20 10 20 10 20 10 20 $NN = 15V_{DC}$ 10 10 20 10 20 10 20 10 20 10 20 10 20 $N = 15V_{DC}$ 10 10 20 10 20 10 20 10 10 20 10 20	$\dot{V} + = 5V_{OC}R_{1} \ge 10K_{1}$ 5205205100 W_{OC} $V_{O} = 2V_{DC}$ $W_{O} = 2V_{DC}$ <td< td=""><td></td><td> R_L ≥ 10 kΩ (LM2904, V⁺ = 26 V_{DC})</td><td>27</td><td>28</td><td>27</td><td>28</td><td></td><td>27</td><td>28</td><td>27</td><td>28</td><td></td><td>27</td><td>28</td><td></td><td>23</td><td>4</td><td>~</td></td<>		R _L ≥ 10 kΩ (LM2904, V ⁺ = 26 V _{DC})	27	28	27	28		27	28	27	28		27	28		23	4	~
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	$ \begin{pmatrix} V_0 = 2 V_{DC} \\ V_N + = 15 V_{DC} \\ V_N + = 16 V_{DC} \\ V_N + V_{DC} \\ V_N $		$V^+ = 5 V_{DC}, R_L \ge 10 k\Omega$		5 20		ъ	20		5 20		S	20		5	20		5 10	E
$\frac{V_{IN} - = +1.V_{DC}}{V_{IN} + = 0 V_{DC}}$ $\frac{V_{IN} - = +1.V_{DC}}{V_{I} + 15 V_{DC}}$ $\frac{V_{IN} - = 15 V_{DC}}{V_{DC}}$ $\frac{V_{IN} - V_{DC}}{V_{DC}}$ $\frac{V_{DC}}{V_{DC}}$ $\frac{V_{IN} - V_{DC}}{V_{DC}}$ $\frac{V_{IN} - V_{DC}}{V_{DC}}{V_{DC}}$ $\frac{V_{IN}$	$\frac{ v_{1}v_{1} ^{2} = \pm1^{2} \text{O}_{D} (v_{1}v_{1}^{2} = 0 \text{V}_{D})}{\sqrt{v_{1}^{2} = \pm15 \text{V}_{D}}} \frac{ v_{2}v_{1} ^{2} = 15 \text{V}_{D}}{\sqrt{v_{D}}} \frac{ v_{2}v_{1} ^{2} = 15 \text{V}_{D}}{\sqrt{v_{D}}} \frac{ v_{2}v_{1} ^{2} = 15 \text{V}_{D}}{\sqrt{v_{D}}} \frac{ v_{2}v_{2} ^{2} = 15 \text{V}_{D}}{\sqrt{v_{D}}} \frac{ v_{2}v_{$		$\begin{array}{l} V_{O}=2V_{DC}\\ V_{IN}^{+}=+1V_{DC},V_{IN}^{-}=0V_{DC},\\ V^{+}=15V_{DC}\end{array}$	10	20	10	20		10	20	10	20		10	20		10	Q	<u> </u>
ating at high temperatures, the LM35B/LM35BA, LM2904 must be derated based on a + 125°C maximum junction temperature and a thermal resistance of 120°C/W which applies for the device soldered in a printed rating in a still air ambient. The LM25B/LM25BA, LM25BA and LM15B/LM15BA can be derated based on a + 150°C maximum junction temperature. The dissipation is the total of both amplifiers—use external resistors, where v the ampliture to saturate or to reduce the power which is dissipated in the impact advicts to ground, the maximum output current is approximately 40 mA independent of the magnitude of supply voltage in excess of + 15 V _{DC} , continuous shortscions, when one output to V ⁺ can cause excessive heading and evane addition. When considering short circuits to ground, the maximum output current is approximately 40 mA independent of the magnitude of supply voltage in excess of + 15 V _{DC} , continuous shorts can be over dissipation ratings and cause eventual destruction. Destruction distribution is the rotal of the tan applies for the ground to a large on to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the op amps to go to the V ⁺ voltage level (or to ground to a large to thind do to 75 s ⁻ 5 + 45 s ⁻ c and the IM55B/LM35BA. LM55BA temperature specifications are limited to -55° C s ⁻ T s + 125^{\circ} cmate. LM55B/LM15BA temperature specifications are limited to -55° C s ⁻ T s + 125^{\circ} cmate 101 input common-mode range (0° to 0^{-} to -15° C s ⁻ T s s + 125^{\circ} to the LM158/LM15BA. With the LM258/LM25BA implexed is which was required as implexed and the reduction. Description and the rotation can exceed the power dissipation ratings and cause whore a current is out of the 0 - 55^{\circ} C s T s s + 85^{\circ}. The LM558/LM25BA temperature is limited to -55° C s T s s + 85^{\circ}. The LM558/LM35BA temperature effection of the input voltage, which was regative, again returms to a value g	ating at high temperatures, the LMSBA/LMSBA, LM2B04 must be derated based on a + 125°C maximum junction temperature and a thermal resistance of 120°C/W which applies for the device soldered in a printed rating and setulation. The integrated critur. The ambient. The LMSBA/LMSBA and LMISE/LMSBA AND AND AND AND AND AND		$V_{IN}^{-} = +1 V_{DC}, V_{IN}^{+} = 0 V_{DC}, V_{+} = 15 V_{DC}$	10	15	5	œ		ъ	8	Ω.	80		ß	80		5	œ	E
ouls from the output for a cause excessive heating and evenuel destruction. When considering stinc fructions the maximum output current is approximately 40 mA independent of the magnitude of supply voltage in excess of +15 Vp _C , continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers. It current is approximately when the overlup of the piput leads is driven negative. It is due to the collector-base junction of the input PNT masistors becoming forward biased and thereby acting as input diode on to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the op amps to go to the V ⁺ voltage level for to ground for a large to the transitor action on the IC chip. This transistor action can cause the output voltage, which was negative. This is not destructive and normal output states will excertablish when the input VPT and the M250 KJ set +125°C for the LM550/LM56A. With the LM256/LM256A itemperature specifications are limited to $-55°C \le T_{\rm A} \le +125°C$ for the LM550/LM56A. With the LM256/LM256A, and to $V^2 < T_{\rm A} \le +13°C$, the LM558/LM356A temperature elimited to $V^2 < T_{\rm A} \le +13°C$ and the LM558/LM356A temperature specifications are limited to $-55°C \le T_{\rm A} \le +125°C$ for the LM558/LM356A temperature specifications are limited to $V^2 < T_{\rm A} \le +13°C$ and the LM558/LM356A temperature elimited to $V^2 < T_{\rm A} < +3°C$. The J second solve specifications are limited to $V^2 < T_{\rm A} < +13°C$ and the LM558/LM356A temperature elimited to $V^2 < T_{\rm A} < +3°C$. The ID setup can be availed and the reby acting as input diode and to the input voltage of the negative. This current is essentially constant, independent of the state of the output so not of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no ording change evel to the t	substrom the output to V^+ can cause excessive heating and evanual estruction. When considering short current is on public Unstruct and evanual estruction. When considering short current will only exist when the Volge, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers at current will only exist when the Volge, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction. Setup to the bar V^+ by the action on the IC of the. This transistor action can cause the output voltage, which was negative, again returns to a value greater than -0.3 Voc (at 25°C). The input is driven negative. This is not extractive and rormal output states will repeating as input diade action, there is also lateral NPN parasitic transistor action on the IC oth. This transistor action can cause the output voltage, which was negative, again returns to a value greater than -0.3 Voc (at 25°C). The output so that an input is driven negative. This is not extractive and rormal output states will repeating the proving the states will repeate the row of the states will repeate the row of the states will repeated to the CC $\leq T_A \leq +13°C$ for the LMISBA/LMISBA, With the LMISBA/LM25BA, all temperature specifications are limited to $-2°C \leq T_A \leq +8°C$, the LM3SB/LM35BA temperature and the tothe current is on of the IC due to the PNP input sommon-mode range (0 Voc to V ⁺ - 1.5 Voc) at 2°C (2 $\leq T_A \leq +10°C$, and the IC due to the PNP induct sommon-mode range (0 Voc to V ⁺ - 1.5 Voc) at 2°C (2 $\leq T_A \leq +10°C$, that LM3SB/LM35BA temperature and to the current is out of the IC due to the PNP induct sommon-mode voltage avaits that -0.3 Voc (at 2°C), but there induct signal voltage should not be allowed to generative byte of the output so to not the IC due to the PNP induct sommon-mode voltage and the task of the LM3SB/LM35BA temperature specifications are timined tor CC $\leq T_A \leq +8°C$	ating at I erating in v the am	iigh temperatures, the LM35B/LM35BA, LM290 a still air ambient. The LM25B/LM25BA and LN plifter to saturate or to reduce the power which	04 must k M158/LM th is dissi	be derated ba: 1158A can be pated in the ir	sed on a derated ntegrate	a +125°C r based on a d circuit.	maximum a +150°C	junction	temperature im junction te	and a th imperatu	ermal res re. The di	stance of ssipation i	120°C/V s the tot	V which ap al of both a	plies for t tmplifiers-	he devid	ternal resis	in a prin tors, wh
pecifications are limited to -55° C \leq T _A \leq +125°C for the LM158/LM158A. With the LM268/LM258A, all temperature specifications are limited to -55° C \leq T _A \leq +125°C for the LM358/LM356A temperature bencifications are limited to -55° C \leq T _A \leq +125°C for the LM358/LM356A temperature bencifications are limited to -55° C \leq T _A \leq +125°C for LM2904. We find the LM2904 specifications are limited to -40° C \leq T _A \leq +85°C. T _A \leq +85°C, the LM358/LM356A temperature bencifications are limited to -40° C \leq T _A \leq +85°C, the LM358/LM356A temperature state to $T_{B} \leq$ 500 with V + from 5 V _{DC} to 20 V _{DC} ; and over the full input common-mode range (0 V _{DC} to V + -1.5 V _{DC}) at 25°C. For LM2904, V + from 5 V _{DC} to 26 V _{DC} . The input lines common-mode values of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines. This current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines. This transmoment of the input stage are available of 0 V + 32 V_{C}, without damage (+26 V _{DC} for LM2904), independent of the magnitude of V + incommon-mode values range is 126°C. The upper end of the common-mode values is 126°C, but either or both to external components, insure than coupling values vare packatione of V + incommon-mode water and is the external parts. This typically can be detected as this type of capacitance increases at higher frequencies. For XF6A K for LM56A milanv sendifications and to FT7546X for LM56A milanv sendifications and on FT7546X for LM56A milanv sendifications.	pecifications are limited to -55° C \leq T _A \leq +125°C for the LM158/LM158A. With the LM258/LM258A, all temperature specifications are limited to -55° C \leq T _A \leq +75°C, and the LM258/LM358A temperature i limited to 0° C \leq T _A \leq +70°C, and the LM2904 specifications are limited to -40° C \leq T _A \leq +85°C. For LM2904, V ⁺ from 5 V _{DD} to 80 V _{DC} . To the limit to the internet is out of the PNP injurt stage. This current is essentially constant, independent of the state of the output s on loading charge exists on the input lines. To common-mode voltage of the input current is out of the PNP input stage. This current is essentially constant, independent of the state of the common-mode voltage exists on the input stage. This current is essentially constant, independent of the state of the common-mode voltage range is V ⁺ + -1.5V (at 25°C), but either or both +32 V _{DC} without damage (+26 V _{DC} for LM2904), independent of the magnitude of V ⁺ .	cuits frol supply v ut curren on to this time du	m the output to V ⁺ can cause excessive heatin oldage in excess of +15 Vpc; continuous short t will only exits when the voltage at any of the i s diode action, there is also laterial NPN parasit ration that an input is driven negative. This is an it allot that an input is driven negative.	ing and e t-circuits input lea itic transis tot destru	wentual destri can exceed th ids is driven n stor action on ictive and norr	Inction. V ne powe egative. the IC o nal outp	Vhen consi r dissipatio It is due tr thip. This to ut states w	idering sh on ratings i o the colle transistor i vill re-esta	ort ciruc and caus ector-bas action ca	its to ground se eventual d se junction o an cause the en the input	, the max lestructio f the inpt output v voltage,	imum out n. Destru at PNP tra oltages o which wa	put curren tive dissig nsistors b the op ar s negative	it is appr bation ca ecoming mps to g , again re	oximately n result fro forward b o to the V eturns to a	40 mA ind m simulta iased and + voltage value gre	depende aneous d thereb level (c ater the	int of the rr shorts on al y acting as or to ground tn -0.3 V _D	l agnitude l amplifie input die l for a la c (at 25°
-4 V _{DC} , R _S = 00. with V ⁺ from 5 V _{DC} to 30 V _{DC} ; and over the full input common-mode range (0 V _{DC} to V ⁺ - 1.5 V _{DC}) at 25°C. For LM2904, V ⁺ from 5 V _{DC} to 26 V _{DC} . cotion of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines. tcommon-mode voltage of either input againal voltage should not be allowed to go negative by more than 0.3V (at 25°C). The upper end of the common-mode voltage range is V ⁺ - 1.5V (at 25°C), but either or both +32 V _{DC} without damage (+26 V _{DC} for LM2904), independent of the aggnitude of V ⁺ . tcommon-mode voltage of either input lines input lines input stage. This current is essentially constant, independent of the state of the common-mode voltage range is V ⁺ - 1.5V (at 25°C), but either or both +32 V _{DC} without damage (+26 V _{DC} for LM2904), independent of the magnitude of V ⁺ . transition is a state of the common-mode voltage range is not originating via straye stratemation and the seekternal parts. This typically can be detected as this type of capacitance increases at higher frequencies. HETSTAS for LM2904A, millinex sendifications and to RETSFAS for LM16A millinex sendifications.	.4 V _{DC} , R ₅ = 01 with V ⁺ from 5 V _{DC} to 30 V _{DC} ; and over the full input common-mode range (0 V _{DC} to V ⁺ - 1.5 V _{DC}) at 25°C. For LM2904, V ⁺ from 5 V _{DC} to 26 V _{DC} . ection of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines. ection of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the common-mode voltage exists on the input lines. +32 V _{DC} without damage (+ 26 V _{DC} for LM2904), independent of the magnitude of V ⁺ . +32 V _{DC} without damage (+ 26 V _{DC} for LM2904), independent of the magnitude of V ⁺ . Herststat components, insure that couping is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies. HETS158AX for LM158A military specifications and to RETS158X for LM158 military specifications.	specificat e limited	iions are limited to $-55^{\circ}C \le T_A \le +125^{\circ}C$ t to $0^{\circ}C \le T_A \le +70^{\circ}C$, and the LM2904 spec	for the L cifications	M158/LM156 s are limited to	A. With 0 -40°	C ≤ TA ≤	58/LM258. + 85°C.	A, all ter	mperature sp	pecificatio	ons are li	nited to -	-25°C ≤	TA 5 +:	85°C, the	LM358	/LM358A t	emperat
t common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V (at 25°C). The upper end of the common-mode voltage range is V ⁺ – 1.5V (at 25°C), but either or both + 32 V _{DC} without damage (+ 26 V _{DC} for LM2904), independent of the magnitude of V ⁺ . <i>Aroximity of external components, insure that coupling is not originating via stray capacitance</i> between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies.	It common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V (at 25°C). The upper end of the common-mode voltage range is V ⁺ -1.5V (at 25°C), but either or both +32 V _{DC} without damage (+26 V _{DC} for LM2904), independent of the magnitude of V ⁺ . It common-mode voltage and the common-mode voltage range is V ⁺ -1.5V (at 25°C), but either or both event accomponents, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies. RETS158AX for LM158A military specifications and to RETS158X for LM158 military specifications.	.4 V _{DC} , F	$R_S = 0.0$ with V ⁺ from 5 V _{DC} to 30 V _{DC} ; and the input current is out of the IC due to the PN	I over the	e full input cor stage. This cu	mmon-m	ode range essentially	 (0 V_{DC} tí r constant 	· · · · · ·	1.5 V _{DC}) at 2 ndent of the	25°C. For state of	LM2904, the outpu	V ⁺ from t so no lo	5 V _{DC} to ading ch	o 26 V _{DC} . ange exist	s on the	input lin	es.	
roximity of external components, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies.	proximity of external components, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies. In ETS158AX for LM158A military specifications and to RETS158X for LM158 military specifications.	ut commo +32 V _D	$_{\rm C}$ mode voltage of either input signal voltage sl $_{\rm C}$ without damage (+26 V _{DC} for LM2904), ind	should no	ot be allowed t of the magr	o go nei	gative by π f V+.	nore than	0.3V (at	25°C). The u	pper end	of the co	om-nomm	de volta	ge range is	s V+ −1.	5V (at 2	5°C), but ei	ther or b
		proximity BETS15	of external components, insure that coupling is 38X for LM158A military specifications and to	s not orig	inating via stra 58X for LM15	ay capa: 3 militar	citance bet v specifica	tween the tions.	se exteri	nal parts. Thi	s typicall	y can be	detected a	is this tyl	pe of capa	citance in	Icreases	at higher f	requenc



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1M

Typical Performance Characteristics (Continued) (LM2902 only)





TL/H/7787-5

Application Hints

The LM158 series are op amps which operate with only a single power supply voltage, have true-differential inputs, and remain in the linear mode with an input common-mode voltage of 0 V_{DC}. These amplifiers operate over a wide range of power supply voltage with little change in performance characteristics. At 25°C amplifier operation is possible down to a minimum supply voltage of 2.3 V_{DC}.

Precautions should be taken to insure that the power supply for the integrated circuit never becomes reversed in polarity or that the unit is not inadvertently installed backwards in a test socket as an unlimited current surge through the resulting forward diode within the IC could cause fusing of the internal conductors and result in a destroyed unit.

Large differential input voltages can be easily accomodated and, as input differential voltage protection diodes are not needed, no large input currents result from large differential input voltages. The differential input voltage may be larger than V⁺ without damaging the device. Protection should be provided to prevent the input voltages from going negative more than $-0.3 V_{DC}$ (at 25°C). An input clamp diode with a resistor to the IC input terminal can be used.

To reduce the power supply current drain, the amplifiers have a class A output stage for small signal levels which converts to class B in a large signal mode. This allows the amplifiers to both source and sink large output currents. Therefore both NPN and PNP external current boost transistors can be used to extend the power capability of the basic amplifiers. The output voltage needs to raise approximately 1 diode drop above ground to bias the on-chip vertical PNP transistor for output current sinking applications.

For ac applications, where the load is capacitively coupled to the output of the amplifier, a resistor should be used, from the output of the amplifier to ground to increase the class A bias current and prevent crossover distortion. Where the load is directly coupled, as in dc applications, there is no crossover distortion. Capacitive loads which are applied directly to the output of the amplifier reduce the loop stability margin. Values of 50 pF can be accomodated using the worst-case non-inverting unity gain connection. Large closed loop gains or resistive isolation should be used if larger load capacitance must be driven by the amplifier.

The bias network of the LM158 establishes a drain current which is independent of the magnitude of the power supply voltage over the range of 3 V_{DC} to 30 V_{DC} .

Output short circuits either to ground or to the positive power supply should be of short time duration. Units can be destroyed, not as a result of the short circuit current causing metal fusing, but rather due to the large increase in IC chip dissipation which will cause eventual failure due to excessive function temperatures. Putting direct short-circuits on more than one amplifier at a time will increase the total IC power dissipation to destructive levels, if not properly protected with external dissipation limiting resistors in series with the output leads of the amplifiers. The larger value of output source current which is available at 25°C provides a larger output current capability at elevated temperatures (see typical performance characteristics) than a standard IC op amp.

The circuits presented in the section on typical applications emphasize operation on only a single power supply voltage. If complementary power supplies are available, all of the standard op amp circuits can be used. In general, introducing a pseudo-ground (a bias voltage reference of V + /2) will allow operation above and below this value in single power supply systems. Many application circuits are shown which take advantage of the wide input common-mode voltage range which includes ground. In most cases, input biasing is not required and input voltages which range to ground can easily be accommodated.



LM158/LM258/LM358/LM158A/LM258A/LM358A/LM2904

2-390







Typical Single-Supply Applications (V⁺ = 5.0 V_{DC}) (Continued)



DC Coupled Low-Pass RC Active Filter

TL/H/7787-26

TL/H/7787-27



Bandpass Active Filter





