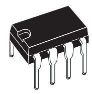
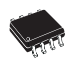
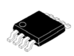
LM158, LM258, LM358
LM158A, LM258A, LM358A

Low Power Dual Operational Amplifiers

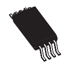
- **Internally frequency compensated**
- **Large DC voltage gain: 100dB**
- **Wide bandwidth (unity gain): 1.1mHz** (temperature compensated)
- **Very low supply current/op (500µA) essentially independent of supply voltage**
- **Low input bias current: 20nA** (temperature compensated)
- **Low input offset voltage: 2mV**
- **Low input offset current: 2nA**
- **Input common-mode voltage range includes ground**
- **Differential input voltage range equal to the power supply voltage**
- **Large output voltage swing 0V to (Vcc - 1.5V)**



N
DIP-8
(Plastic Package**)**

D & S
SO-8 & mini SO-8
(Plastic Micropackage**)**



P
TSSOP8
(Thin Shrink Small Outline Package)

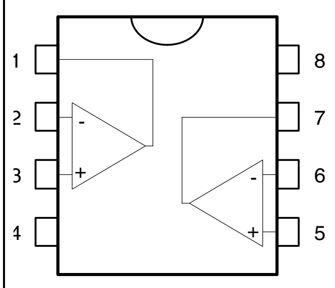
Description

These circuits consist of two independent, high-gain, internally frequency-compensated which were designed specifically to operate from a single power supply over a wide range of voltages. The low power supply 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, these circuits can be directly supplied with the standard +5V which is used in logic systems and will easily provide the required interface electronics without requiring any additional power supply.

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..

Pin Connections (top view)

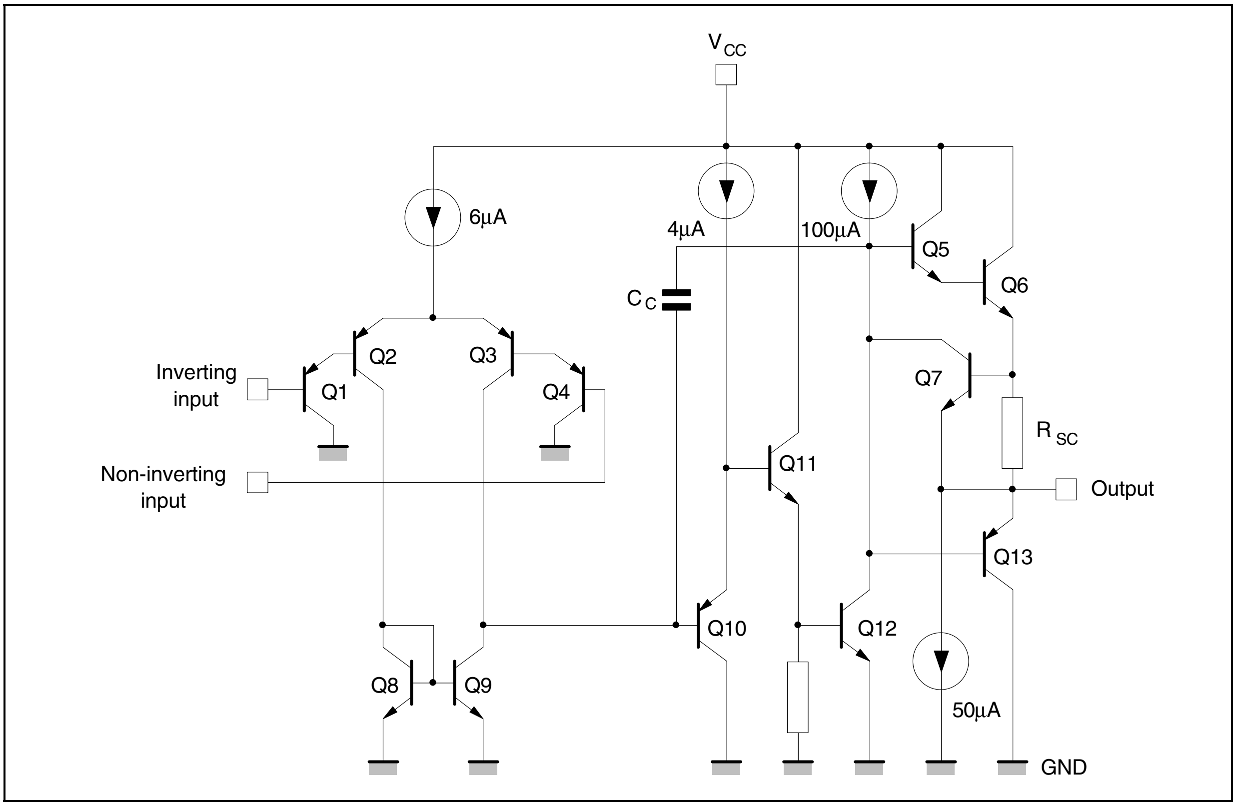


1 - Output 1
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^-
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - V_{CC}^+

Order Codes

Part Number	Temperature Range	Package	Packaging	Marking
LM158N	-55°C, +125°C	DIP-8	Tube	
LM158D LM158DT		SO-8	Tube or Tape & Reel	
LM158APT		TSSOP-8 (Thin Shrink Outline Package)	Tape & Reel	
LM258N LM258AN	-40°C, +105°C	DIP-8	Tube	
LM258D LM258DT LM258AD LM258ADT		SO-8	Tube or Tape & Reel	
LM258PT LM258APT		TSSOP-8 (Thin Shrink Outline Package)	Tape & Reel	
LM358N LM358AN	0°C, +70°C	DIP-8	Tube	
LM358D LM358DT LM358AD LM358ADT		SO-8	Tube or Tape & Reel	
LM358PT LM358APT		TSSOP-8 (Thin Shrink Outline Package)	Tape & Reel	
LM358ST LM358AST		mini SO-8	Tape & Reel	

Figure 1. Schematic diagram (1/2 LM158)



1 Absolute Maximum Ratings

Table 1. Key parameters and their absolute maximum ratings

Symbol	Parameter	LM158,A	LM258,A	LM358,A	Unit
VCC	Supply voltage	+/-16 or 32			V
Vi	Input Voltage	-0.3 to +32			V
V_{id}	Differential Input Voltage	+32			V
P_{tot}	Power Dissipation [1]	500			mW
	Output Short-circuit Duration [2]	Infinite			
I_{in}	Input Current [3]	50			mA
T_{oper}	Operating Free-air Temperature Range	-55 to +125	-40 to +105	0 to +70	°C
T_{stg}	Storage Temperature Range	-65 to +150			°C
T_j	Maximum Junction Temperature	150			°C
R_{thja}	Thermal Resistance Junction to Ambient[4] SO8 TSSOP8 DIP8 miniSO8	 125 120 85 190			°C/W

1) Power dissipation must be considered to ensure maximum junction temperature (Tj) is not exceeded.

2) Short-circuits from the output to V_{CC} can cause excessive heating if V_{CC} > 15V. The maximum output current is approximately 40mA independent
of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short-circuit on all amplifiers.

3) This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP
transistor becoming forward biased and thereby acting as input diodes clamps. In addition to this diode action, there is also NPN parasitic action on
the IC chip. this transistor action can cause the output voltages of the Op-amps to go to the V_{CC} voltage level (or to ground for a large overdrive)
for the time duration than an input is driven negative.
This is not destructive and normal output will set up again for input voltage higher than -0.3V.

4) Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuit on all amplifiers

2 Electrical Characteristics

Table 2. Electrical characteristics for V_{CC}^+ = +5V, V_{CC}^-= Ground, V_o = 1.4V, T_{amb} = +25°C (unless otherwise specified)

Symbol	Parameter	LM158A-LM258A LM358A			LM158-LM258 LM358			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{io}	Input Offset Voltage - note [1] T_{amb} = +25°C LM158, LM258 LM158A $T_{min} \le T_{amb} \le T_{max}$ LM158, LM258		1	3 2 4		2	7 5 9 7	mV
I_{io}	Input Offset Current T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$		2	10 30		2	30 40	nA
I_{ib}	Input Bias Current - note [2] T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$		20	50 100		20	150 200	nA
A_{vd}	Large Signal Voltage Gain V_{CC} = +15V, R_L = 2kΩ, V_o = 1.4V to 11.4V T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$	50 25	100		50 25	100		V/mV
SVR	Supply Voltage Rejection Ratio ($R_s \le$ 10kΩ) V_{CC}^+ = 5V to 30V T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$	65 65	100		65 65	100		dB
I_{CC}	Supply Current, all Amp, no load $T_{min} \le T_{amb} \le T_{max}$ V_{CC} = +5V $T_{min} \le T_{amb} \le T_{max}$ V_{CC} = +30V		0.7	1.2 2		0.7	1.2 2	mA
V_{icm}	Input Common Mode Voltage Range V_{CC} = +30V - note [3] T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$	0 0		V_{CC}^+ -1.5 V_{CC}^+ -2	0 0		V_{CC}^+ -1.5 V_{CC}^+ -2	V
CMR	Common Mode Rejection Ratio ($R_s \le$ 10kΩ) T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$	70 60	85		70 60	85		dB
I_{source}	Output Current Source V_{CC} = +15V, V_o = +2V, V_{id} = +1V	20	40	60	20	40	60	mA
I_{sink}	Output Sink Current (V_{id} = -1V) V_{CC} = +15V, V_o = +2V V_{CC} = +15V, V_o = +0.2V	10 12	20 50		10 12	20 50		mA µA
V_{OPP}	Output Voltage Swing (R_L = 2kΩ) T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$	0 0		V_{CC}^+ -1.5 V_{CC}^+ -2	0 0		V_{CC}^+ -1.5 V_{CC}^+ -2	

Table 2. Electrical characteristics for $V_{CC}^+ = +5V$, $V_{CC}^- =$ Ground, $V_o = 1.4V$, $T_{amb} = +25°C$ (unless otherwise specified)

Symbol	Parameter	LM158A-LM258A LM358A			LM158-LM258 LM358			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{OH}	High Level Output Voltage ($V_{CC}^+ = 30V$) $T_{amb} = +25°C$ $R_L = 2k\Omega$ $T_{min} \le T_{amb} \le T_{max}$ $T_{amb} = +25°C$ $R_L = 10k\Omega$ $T_{min} \le T_{amb} \le T_{max}$	26 26 27 27	27 28		26 26 27 27	27 28		V
V_{OL}	Low Level Output Voltage ($R_L = 10k\Omega$) $T_{amb} = +25°C$ $T_{min} \le T_{amb} \le T_{max}$		5	20 20		5	20 20	mV
SR	Slew Rate $V_{CC} = 15V$, $V_i = 0.5$ to $3V$, $R_L = 2k\Omega$, $C_L = 100pF$, unity Gain	0.3	0.6		0.3	0.6		V/µs
GBP	Gain Bandwidth Product $V_{CC} = 30V$, f =100kHz,$V_{in} = 10mV$, $R_L = 2k\Omega$, $C_L = 100pF$	0.7	1.1		0.7	1.1		MHz
THD	Total Harmonic Distortion f = 1kHz, $A_v = 20dB$, $R_L = 2k\Omega$, $V_o = 2V_{pp}$, $C_L = 100pF$, $V_O = 2Vpp$		0.02			0.02		%
e_n	Equivalent Input Noise Voltage f = 1kHz, $R_s = 100\Omega$, $V_{CC} = 30V$		55			55		$\frac{nV}{\sqrt{Hz}}$
DV_{io}	Input Offset Voltage Drift		7	15		7	30	µV/°C
DI_{Iio}	Input Offset Current Drift		10	200		10	300	pA/°C
V_{o1}/V_{o2}	Channel Separation - note 4 $1kHz \le f \le 20kHZ$		120			120		dB

1) $V_o = 1.4V$, $R_s = 0\Omega$, $5V < V_{CC}^+ < 30V$, $0 < V_{ic} < V_{CC}^+ - 1.5V$

2) The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.

3) The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is $V_{CC}^+ - 1.5V$, but either or both inputs can go to +32V without damage.

4) Due to the 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 frequences.

Figure 2. Open loop frequency response

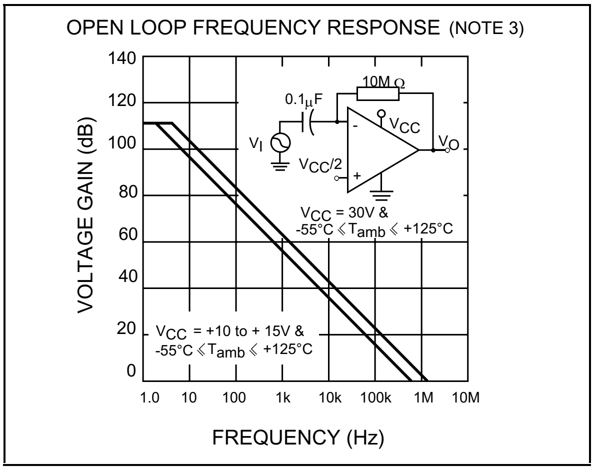


Figure 5. Voltage follower pulse response

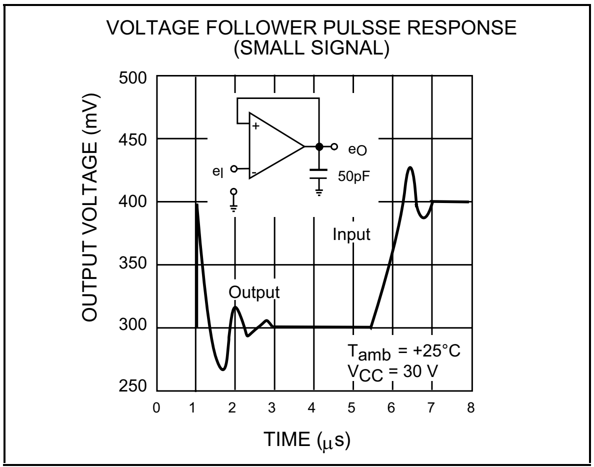


Figure 3. Large signal frequency response

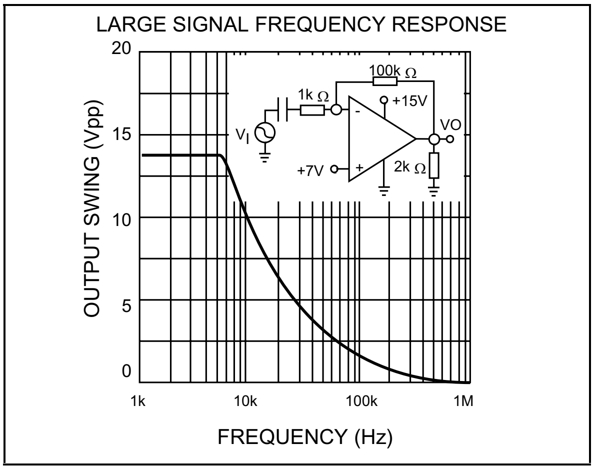


Figure 6. Input current

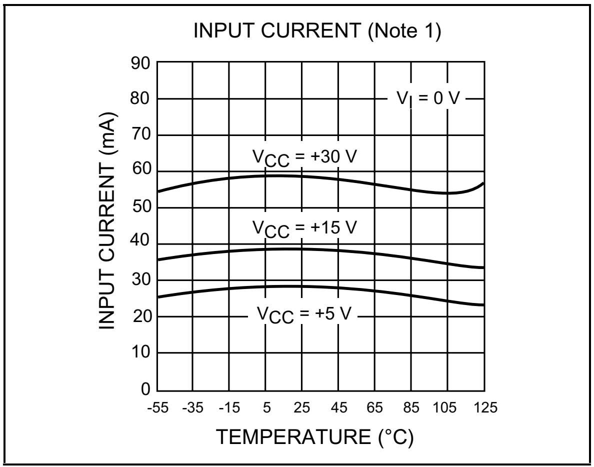


Figure 4. Voltage follower pulse response

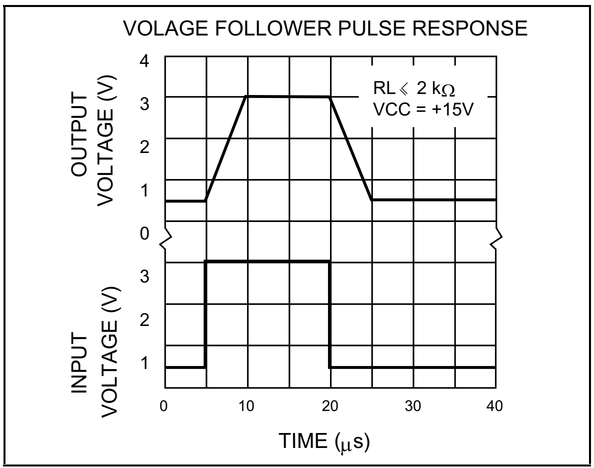


Figure 7. Output characteristics

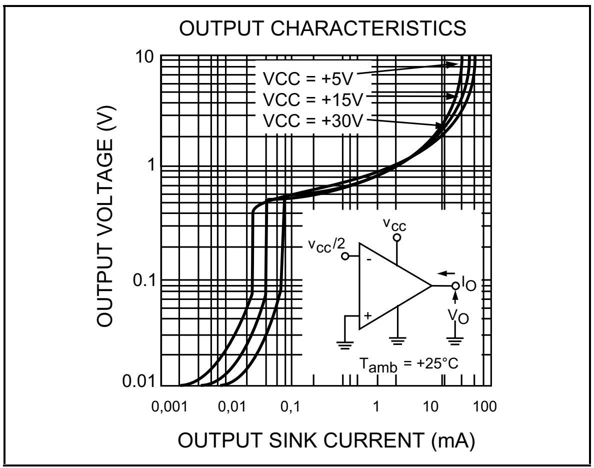


Figure 8. Output characteristics

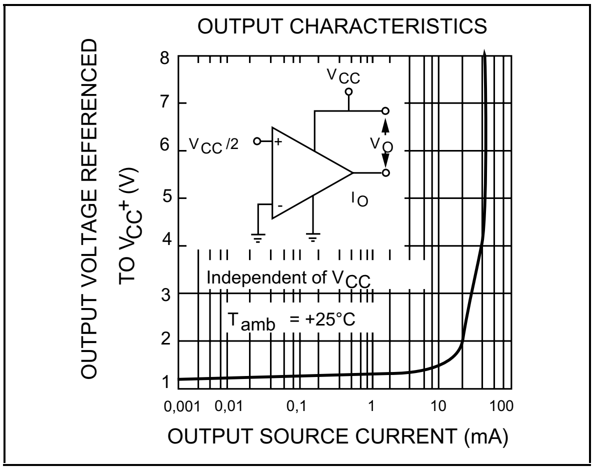


Figure 9. Current limiting

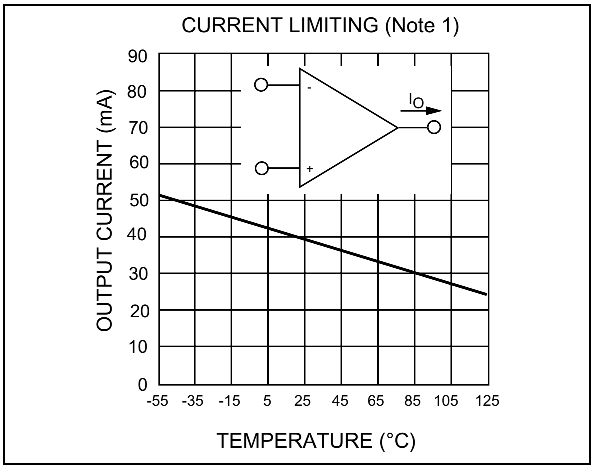


Figure 10. Input voltage range

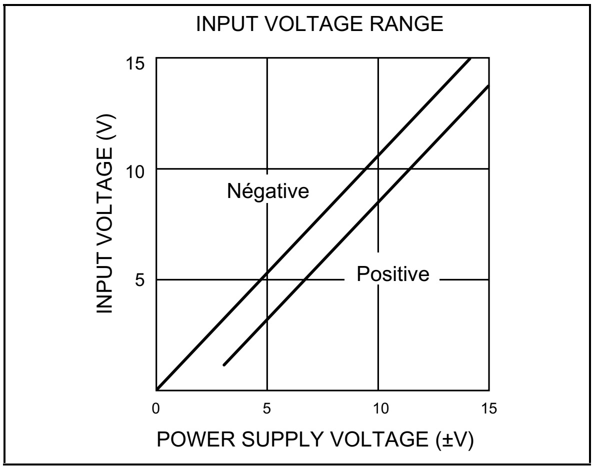


Figure 11. Positive supply voltage

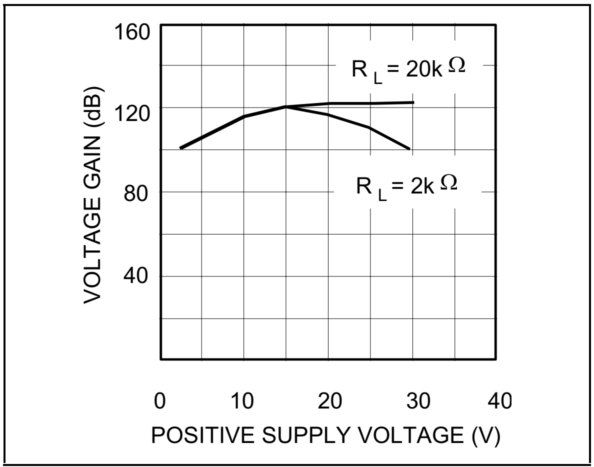


Figure 12. Positive supply voltage

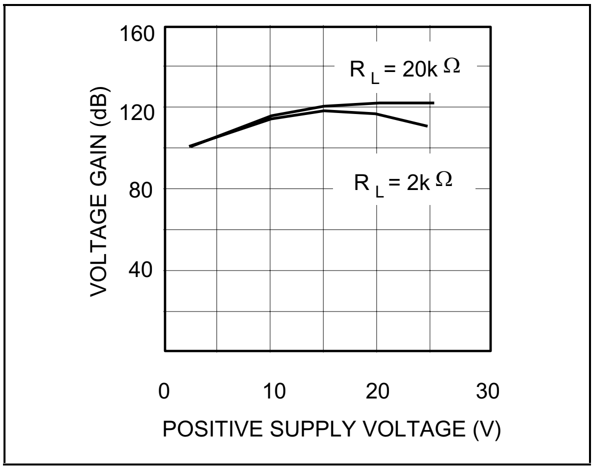


Figure 13. Supply current

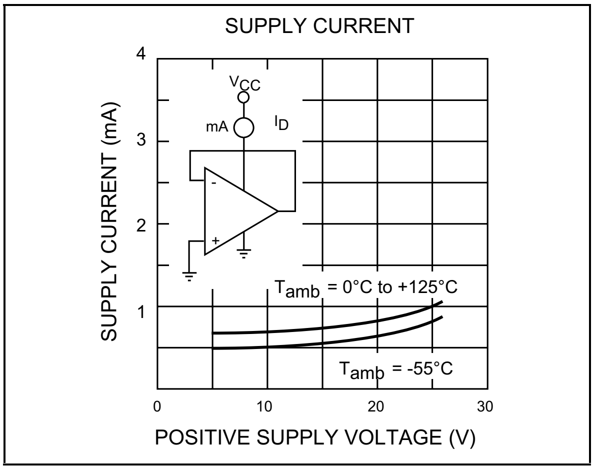


Figure 14. Input current

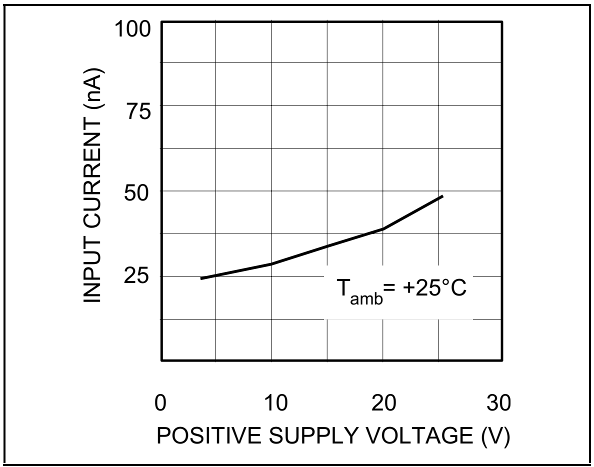


Figure 15. Gain bandwidth product

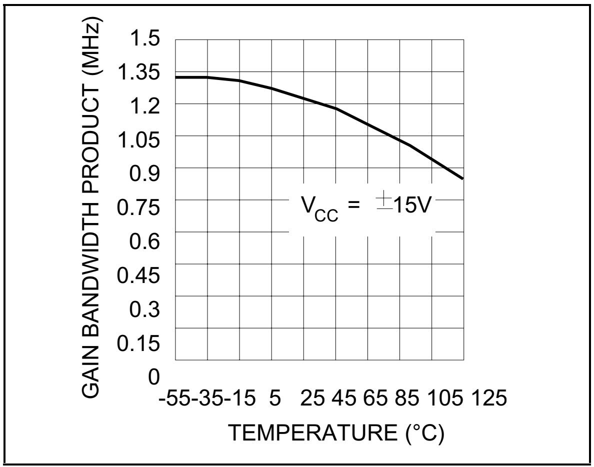


Figure 16. Power supply rejection ratio

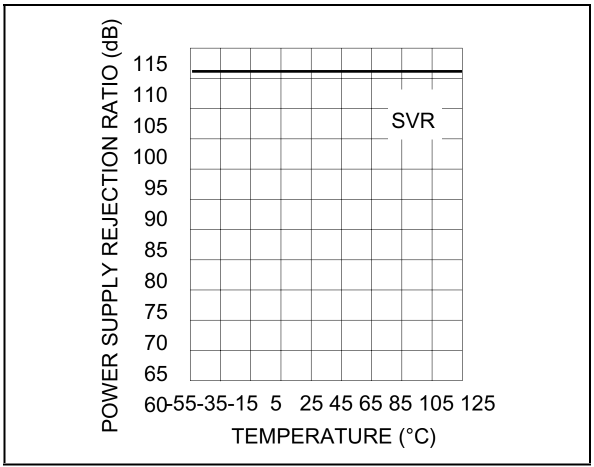
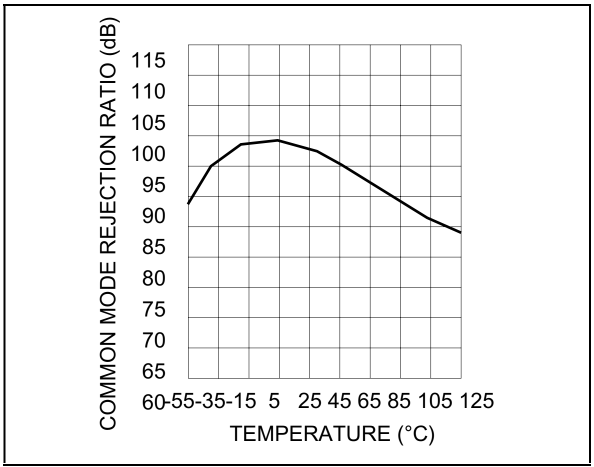


Figure 17. Common mode rejection ratio



3 Typical Applications

(single supply voltage) $V_{cc} = +5V_{dc}$

Figure 18. AC coupled inverting amplifier

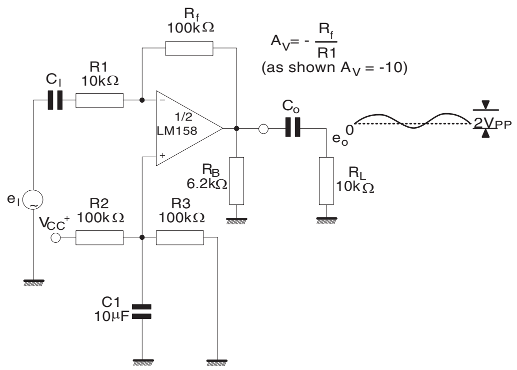


Figure 19. Non-inverting DC amplifier

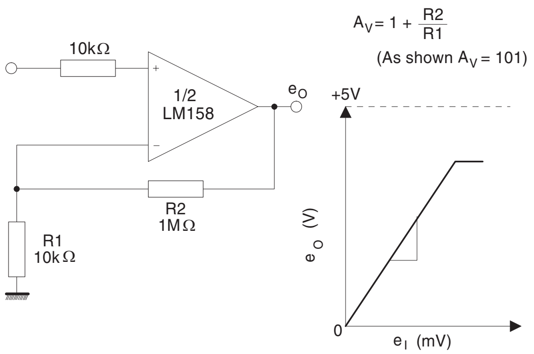


Figure 20. AC Coupled Non-inverting Amplifier

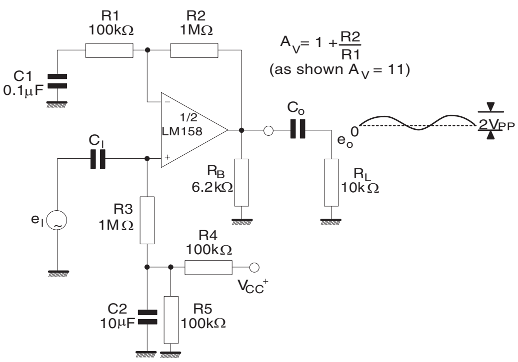
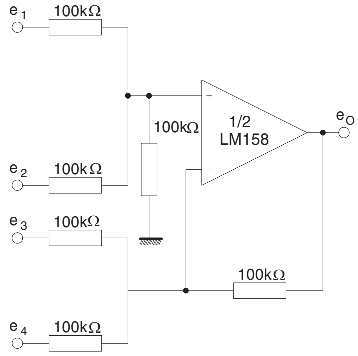
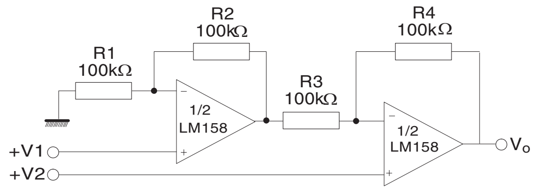


Figure 21. DC summing amplifier



$e_o = e_1 + e_2 - e_3 - e_4$
where $(e1 + e_2) \geq (e_3 + e_4)$
to keep $e_o \geq 0V$

Figure 22. High input Z, DC differential amplifier

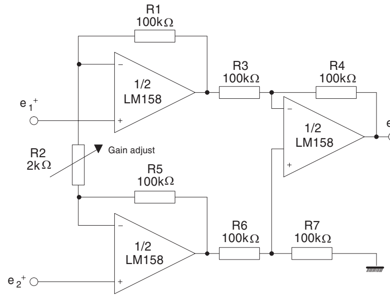


if R1 = R5 and R3 = R4 = R6 = R7

$$e_o = \left[1 + \frac{2R1}{R2}\right]\left((e_2 + e_1)\right)$$

As shown $e_o = 101\ (e_2 + e_1)$

Figure 23. High input Z adjustable gain DC instrumentation amplifier



if R1 = R5 and R3 = R4 = R6 = R7

$$e_o = \left[1 + \frac{2R1}{R2}\right]\left(e_2 + e_1\right)$$

As shown $e_o = 101\ (e_2 + e_1)$

Figure 24. Using symmetrical amplifiers to reduce input current

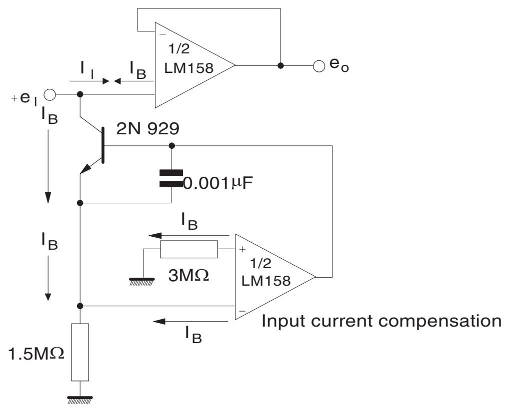


Figure 25. Low drift peak detector

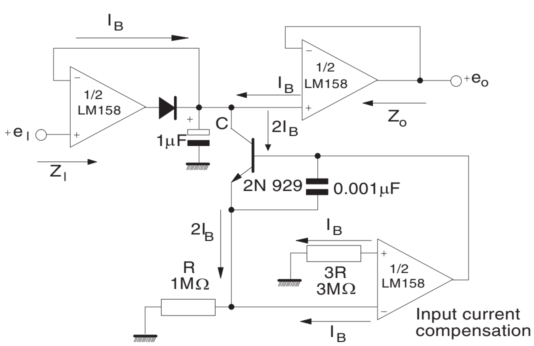
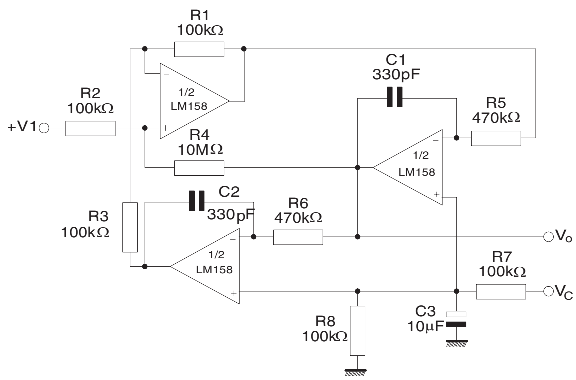


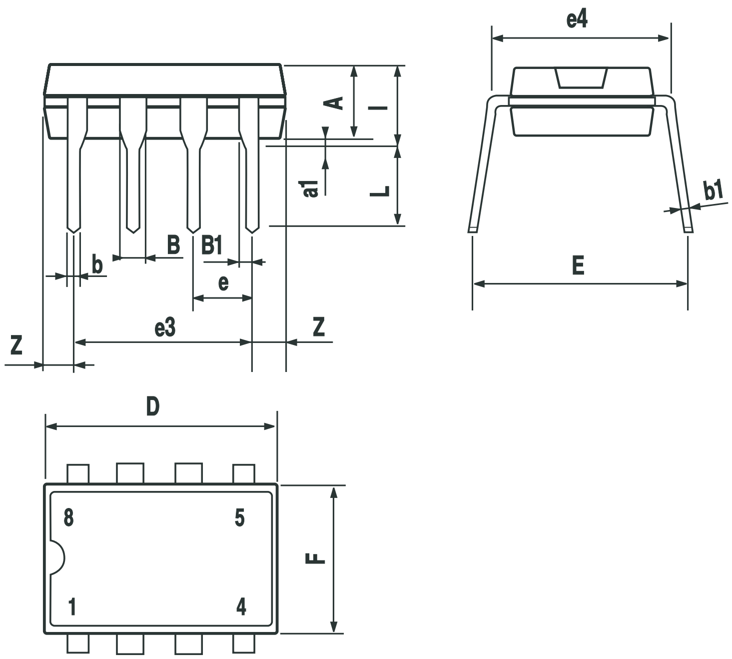
Figure 26. Active band-pass filter



4 Package Mechanical Data

Plastic DIP-8 MECHANICAL DATA

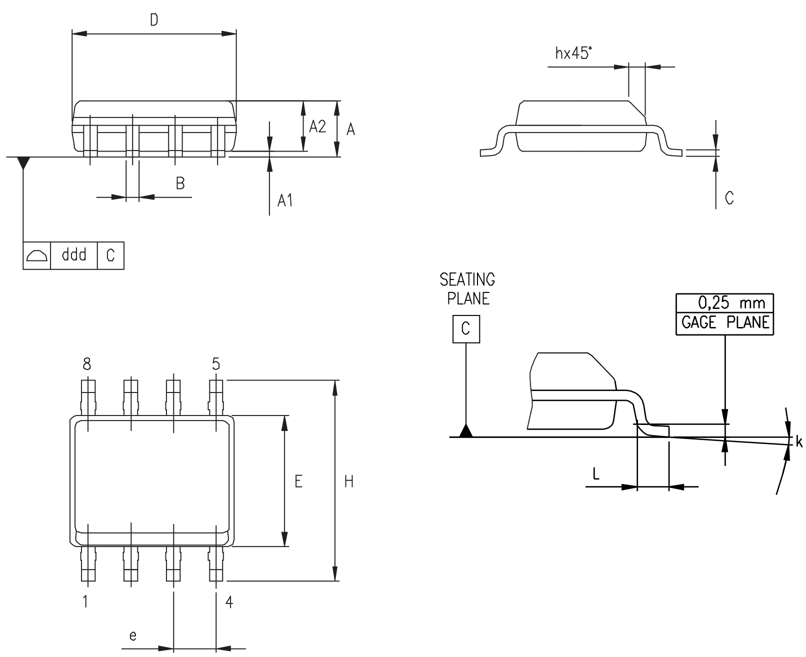
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A		3.3			0.130	
a1	0.7			0.028		
B	1.39		1.65	0.055		0.065
B1	0.91		1.04	0.036		0.041
b		0.5			0.020	
b1	0.38		0.5	0.015		0.020
D			9.8			0.386
E		8.8			0.346	
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			7.1			0.280
I			4.8			0.189
L		3.3			0.130	
Z	0.44		1.6	0.017		0.063



P001F

SO-8 MECHANICAL DATA

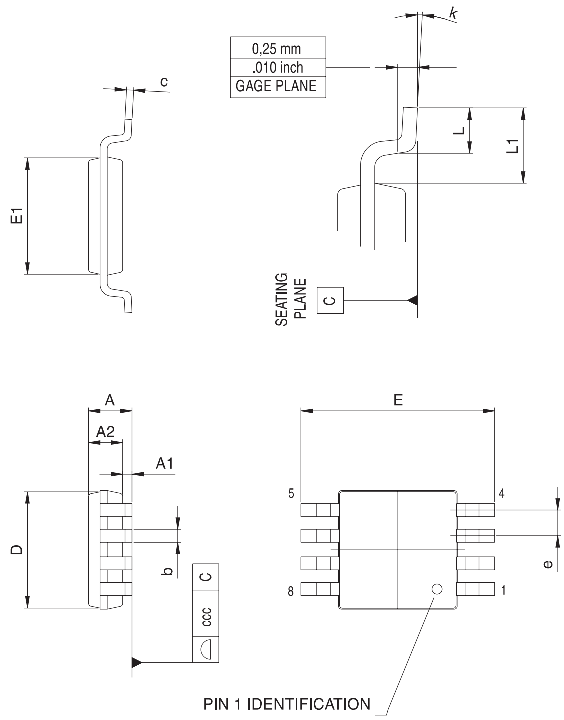
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.04		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D	4.80		5.00	0.189		0.197
E	3.80		4.00	0.150		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	8° (max.)					
ddd			0.1			0.04



0016023/C

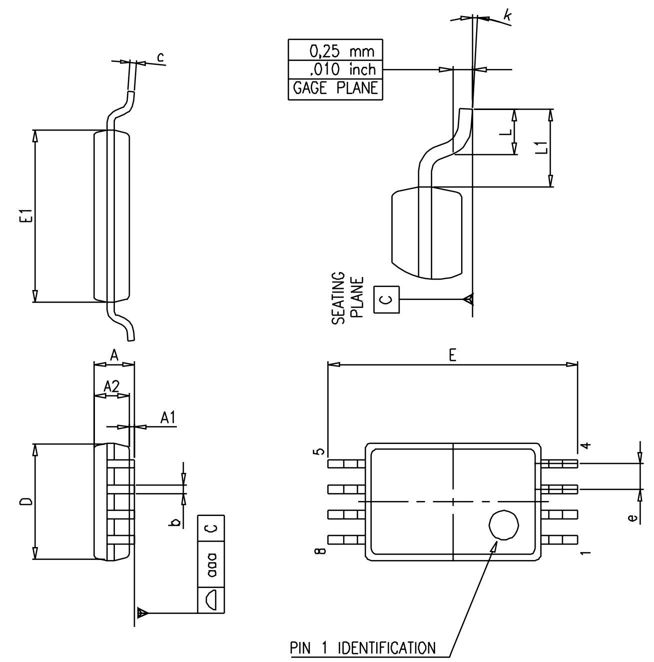
miniSO-8 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.1			0.043
A1	0.05	0.10	0.15	0.002	0.004	0.006
A2	0.78	0.86	0.94	0.031	0.031	0.037
b	0.25	0.33	0.40	0.010	0.13	0.013
c	0.13	0.18	0.23	0.005	0.007	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	4.75	4.90	5.05	0.187	0.193	0.199
E1	2.90	3.00	3.10	.0114	0.118	0.122
e		0.65			0.026	
K	0°		6°	0°		6°
L	0.40	0.55	0.70	0.016	0.022	0.028
L1			0.10			0.004



TSSOP8 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.2			0.047
A1	0.05		0.15	0.002		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.008
D	2.90	3.00	3.10	0.114	0.118	0.122
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.0256	
K	0˚		8˚	0˚		8˚
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1			0.039	



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5 Summary of Changes

Date	Revision	Description of Changes
01 July 2003	1	First Release
01 Jan. 2005	2	Rthja and Tj parameters added in AMR *Table 1 on page 3*