LM158-LM258-LM358

Low power dual operational amplifiers

Features

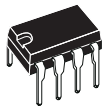
- Internally frequency compensated
- Large DC voltage gain: 100 dB
- Wide bandwidth (unity gain): 1.1 mHz (temperature compensated)
- Very low supply current per operator essentially independent of supply voltage
- Low input bias current: 20 nA (temperature compensated)
- Low input offset voltage: 2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

Description

These circuits consist of two independent, high-gain, internally frequency-compensated op-amps which are 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.

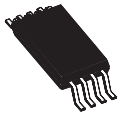
Application areas include transducer amplifiers, DC gain blocks and all the conventional op-amp circuits which now can be more easily implemented in single power supply systems. For example, these circuits can be directly supplied with the standard +5 V which is used in logic systems and will easily provide the required interface electronics without requiring any additional power supply.

In 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.



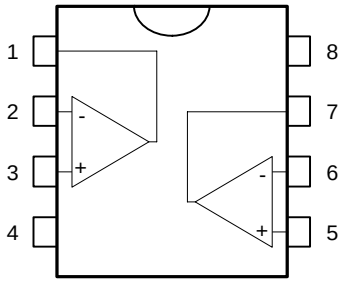
N
DIP-8
(Plastic package)

D & S
SO-8 & miniSO-8
(Plastic micropackage)



P
TSSOP8
(Thin shrink small outline package)

Pin connections
(Top view)

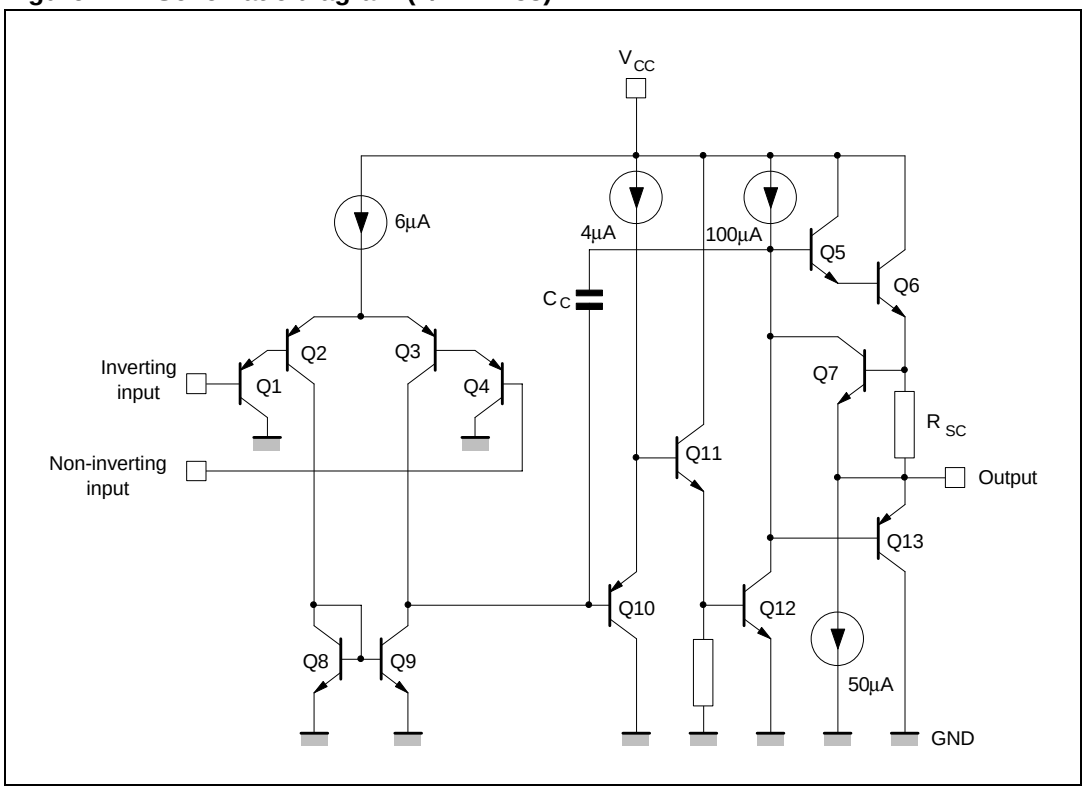


1 - Output 1
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}-
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - V_{CC}+

Contents

1 Schematic diagram

Figure 1. Schematic diagram (1/2 LM158)



2 Absolute maximum ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	LM158,A	LM258,A	LM358,A	Unit
V_{CC}	Supply voltage	+/-16 or 32			V
V_i	Input voltage	32			V
V_{id}	Differential input voltage	32			V
P_{tot}	Power dissipation (1)	500			mW
	Output short-circuit duation (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) (5) SO-8 MiniSO-8 TSSOP8 DIP-8	 125 190 120 85			°C/W
R_{thjc}	Thermal resistance junction to case SO-8 MiniSO-8 TSSOP8 DIP-8	 40 39 37 41			°C/W
ESD	HBM: human body model(6)	300			V
	MM: machine model(7)	200			V
	CDM: charged device model(8)	1.5			kV

1. Power dissipation must be considered to ensure that the maximum junction temperature (T_j) is not exceeded.
2. Short-circuits from the output to V_{CC} can cause excessive heating if V_{CC} > 15 V. The maximum output current is approximately 40 mA independent of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short-circuits 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 diode 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 during which an input is driven negative.
   This is not destructive and normal output is restored for input voltages above -0.3 V.
4. Short-circuits can cause excessive heating and destructive dissipation.
5. R_{th} are typical values.
6. Human body model: A 100pF capacitor is charged to the specified voltage, then discharged through a 1.5kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
7. Machine model: A 200pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5Ω). This is done for all couples of connected pin combinations while the other pins are floating.
8. Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins.

3 Operating conditions

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	3 to 32	V
V_{icm}	Common mode input voltage range T_{amb} = +25° C	V_{DD} -0.3 to V_{CC} -1.5	V
T_{oper}	Operating free air temperature range LM158 LM258 LM358 LM258Y-LM358Y	 -55 - +125 -40 - +105 0 - +70 -40 - +125	°C

4 Electrical characteristics

Table 3. 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 (1) T_{amb} = +25° C LM158, LM258 LM158A		1	3 2		2	7 5	mV
	$T_{min} \le T_{amb} \le T_{max}$ LM158, LM258			4			9 7	
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 (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} = +15 V, R_L = 2 kΩ, V_o = 1.4 V to 11.4 V 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 ($R_S \le 10$ kΩ) V_{CC}^+ = 5 V to 30 V 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} = +5 V $T_{min} \le T_{amb} \le T_{max}$ V_{CC} = +30 V		0.7	1.2 2		0.7	1.2 2	mA
V_{icm}	Input common mode voltage range V_{CC} = +30 V (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 ($R_S \le 10$ kΩ) 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} = +15 V, V_o = +2 V, V_{id} = +1 V	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

Table 3. 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_{OPP}	Output voltage swing (R_L = 2 kΩ) 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_{OH}	High level output voltage (V_{CC}^+ = 30 V) T_{amb} = +25° C, R_L = 2 kΩ $T_{min} \le T_{amb} \le T_{max}$ T_{amb} = +25° C, R_L = 10 kΩ $T_{min} \le T_{amb} \le T_{max}$	 26 26 27 27	 27 28 	 	 26 26 27 27	 27 28 	 	V
V_{OL}	Low level output voltage (R_L = 10 kΩ) 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 = 2kΩ, C_L = 100pF, unity Gain	0.3	0.6		0.3	0.6		V/µs
GBP	Gain bandwidth product V_{CC} = 30 V, f = 100 kHz,V_{in} = 10 mV, R_L = 2 kΩ, C_L = 100 pF	0.7	1.1		0.7	1.1		MHz
THD	Total harmonic distortion f = 1 kHz, A_v = 20 dB, R_L = 2 kΩ, V_o = 2 V_{pp}, C_L = 100 pF, V_O = 2 Vpp		0.02			0.02		%
e_n	Equivalent input noise voltage f = 1 kHz, R_s = 100 Ω, V_{CC} = 30 V		55			55		$\frac{nV}{\sqrt{Hz}}$
DV_{io}	Input offset voltage drift		7	15		7	30	µV/°C
DI_{io}	Input offset current drift		10	200		10	300	pA/°C
V_{o1}/V_{o2}	Channel separation(4) 1kHz ≤ f ≤ 20 kHZ		120			120		dB

1. V_o = 1.4 V, R_s = 0 Ω, 5 V < V_{CC}^+ < 30 V, 0 < V_{ic} < V_{CC}^+ - 1.5 V
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 there is no change in the load 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 0.3 V. The upper end of the common-mode voltage range is V_{CC}^+ - 1.5 V, but either or both inputs can go to +32 V without damage.
4. Due to the proximity of external components, ensure that stray capacitance between these external parts does not cause coupling. Typically, this can be detected because this type of capacitance increases at higher frequencies.

Figure 2. Open loop frequency response

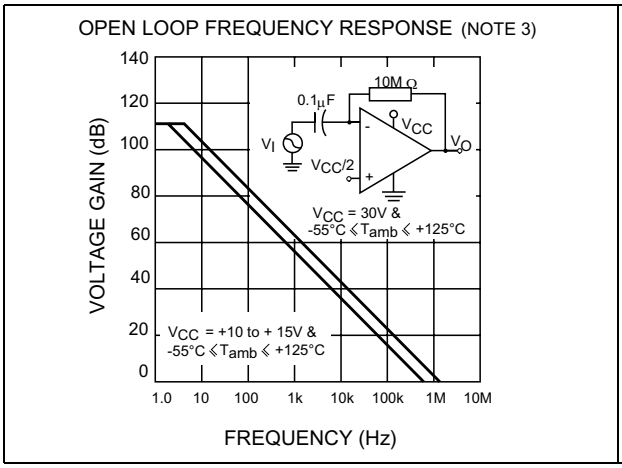


Figure 3. Large signal frequency response

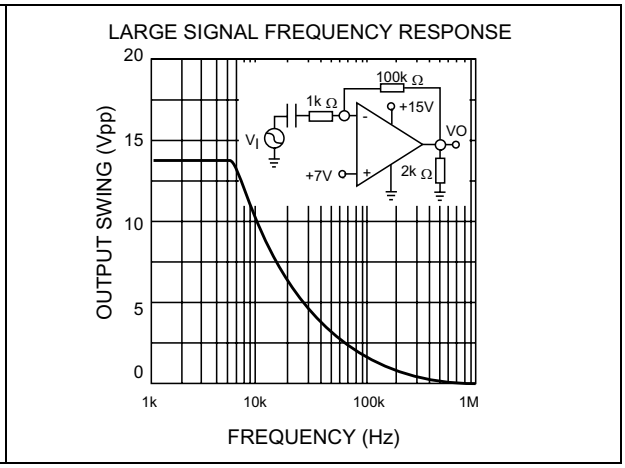


Figure 4. Voltage follower pulse response

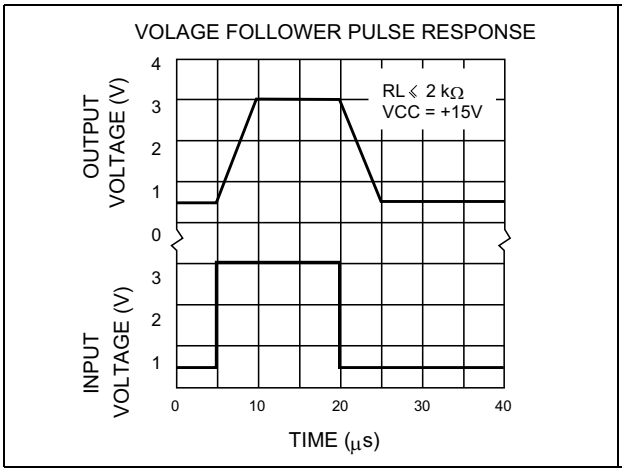


Figure 5. Voltage follower pulse response

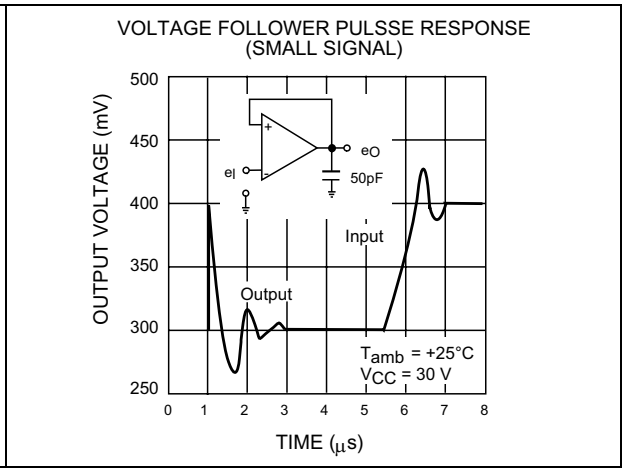


Figure 6. Input current

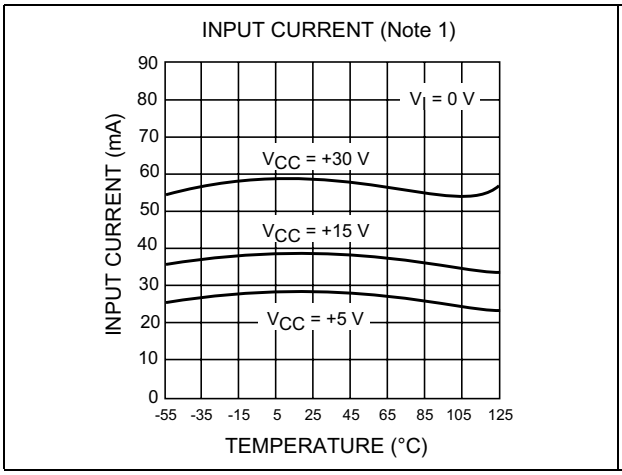


Figure 7. Output characteristics

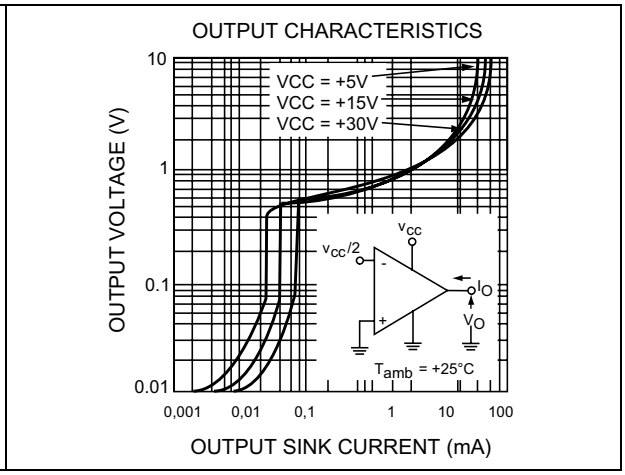


Figure 8. Output characteristics

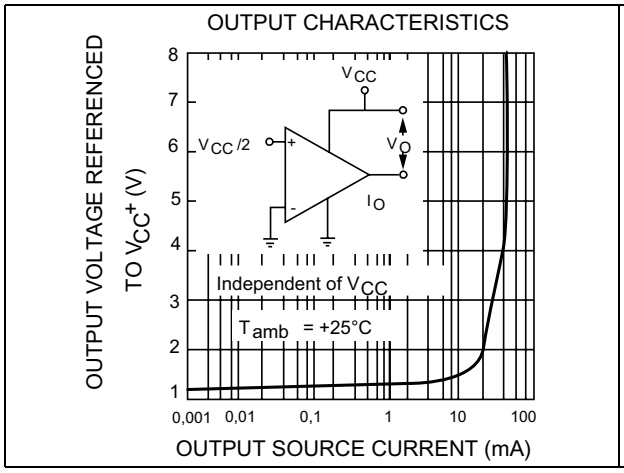


Figure 9. Current limiting

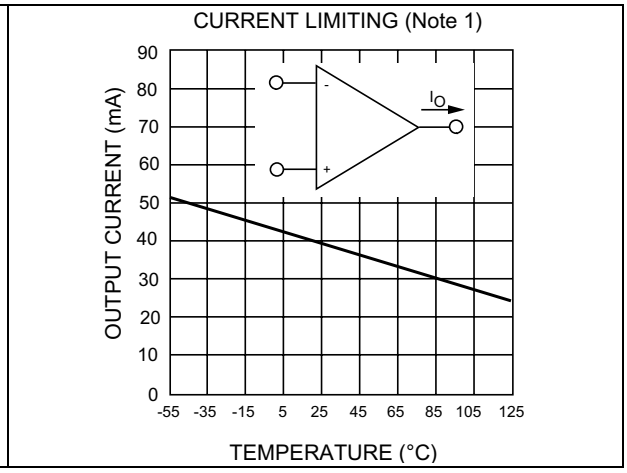


Figure 10. Input voltage range

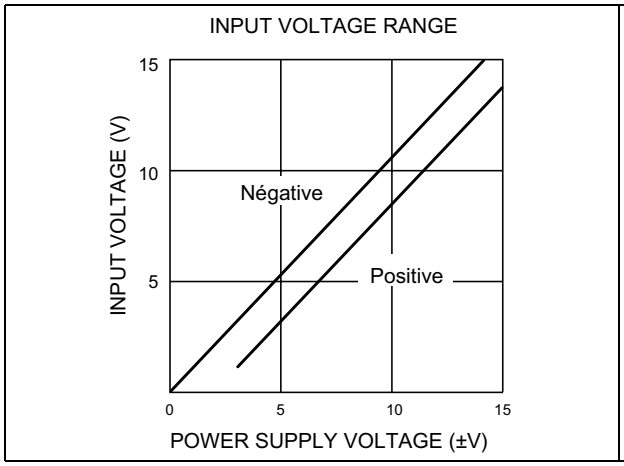


Figure 11. Positive supply voltage

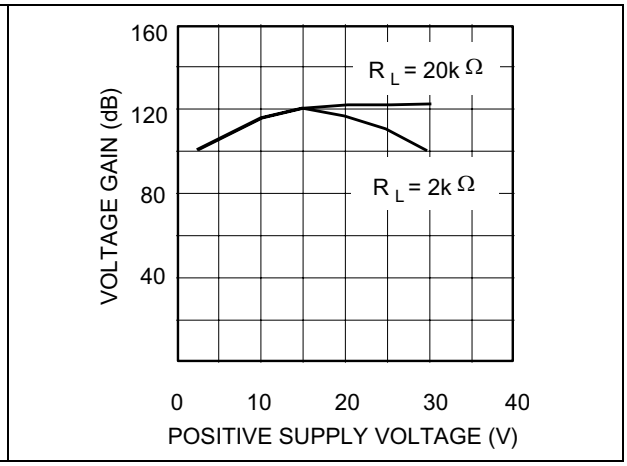


Figure 12. Input voltage range

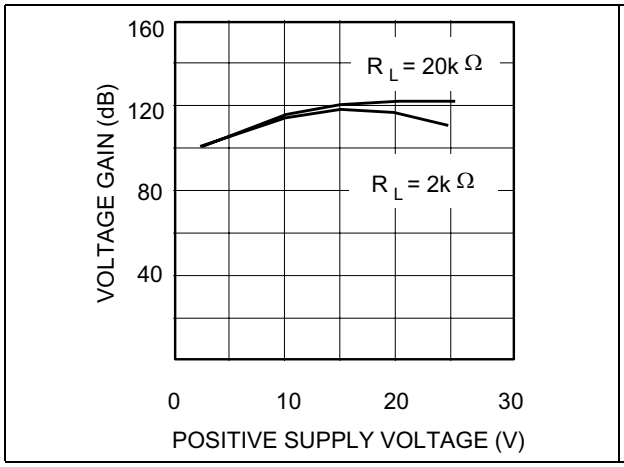


Figure 13. Supply current

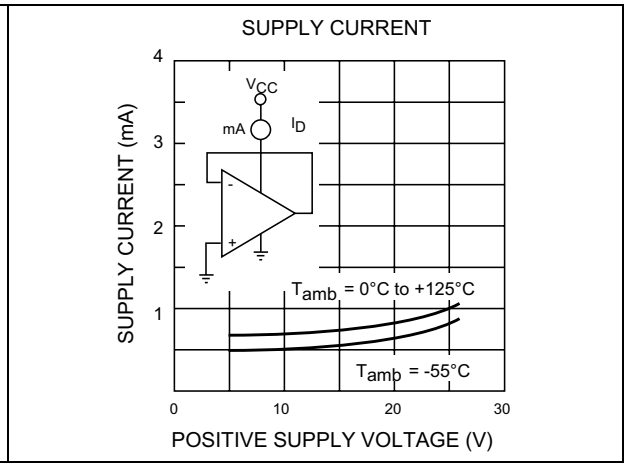


Figure 14. Input current

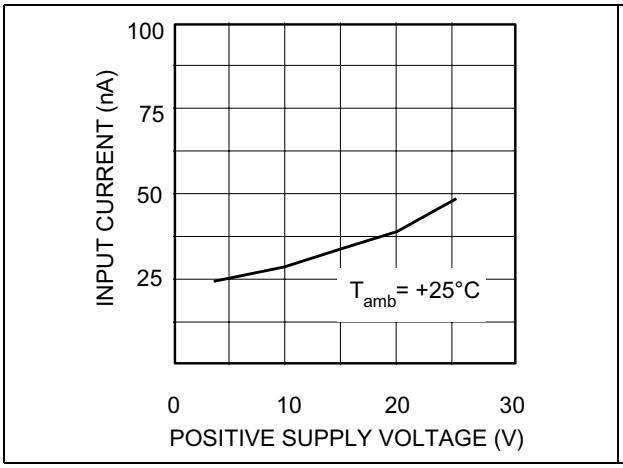


Figure 15. Gain bandwidth product

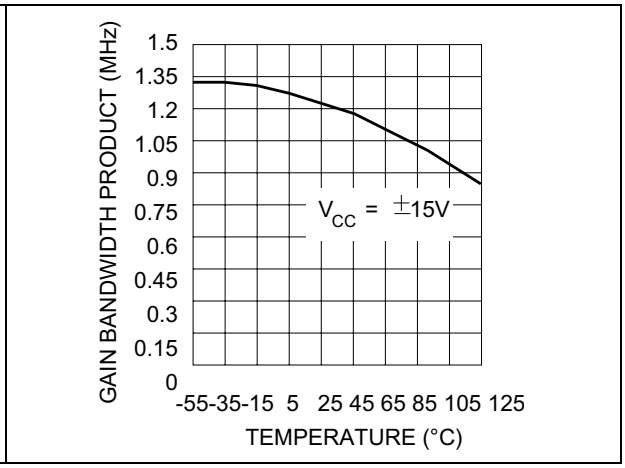


Figure 16. Power supply rejection ratio

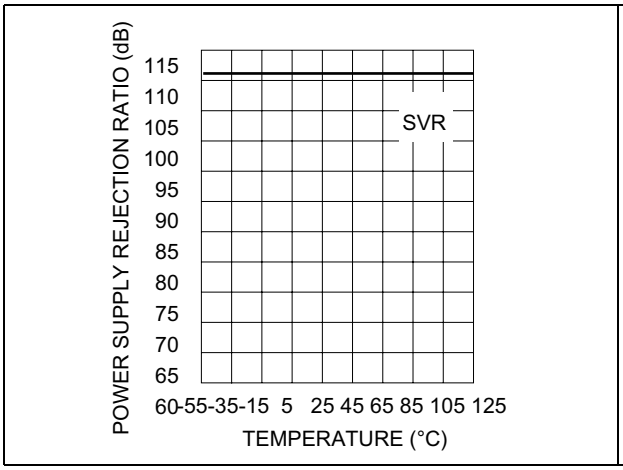


Figure 17. Common mode rejection ratio

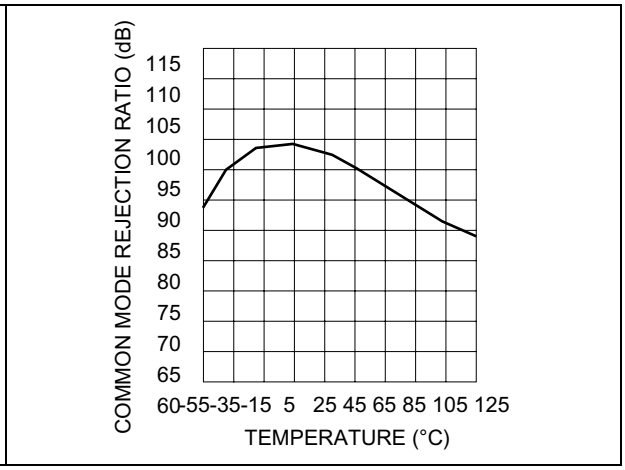
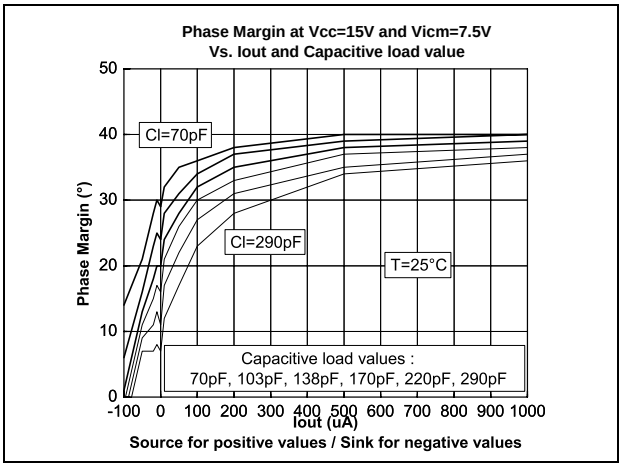


Figure 18. Phase margin vs capacitive load



5 Typical applications

Single supply voltage V_{cc} = +5V_{dc}.

Figure 19. AC coupled inverting amplifier

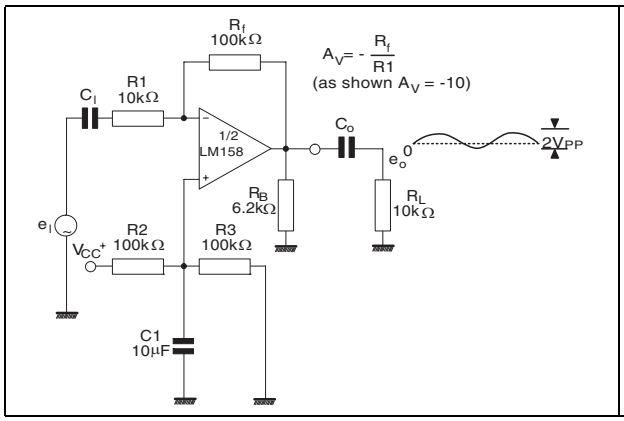


Figure 20. Non-inverting DC amplifier

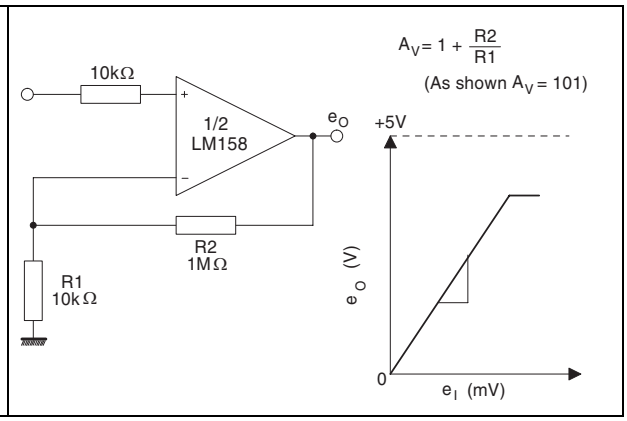


Figure 21. AC coupled non-inverting amplifier

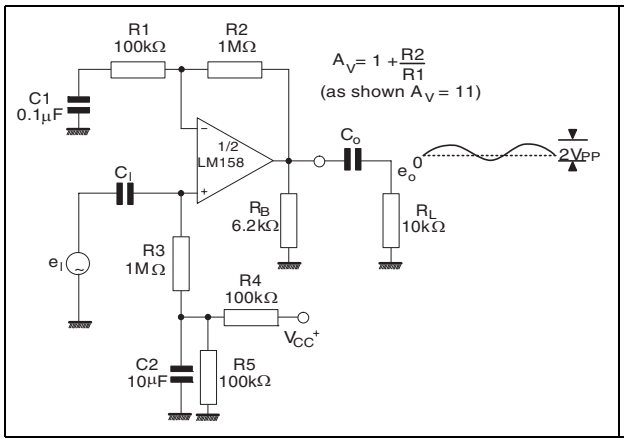
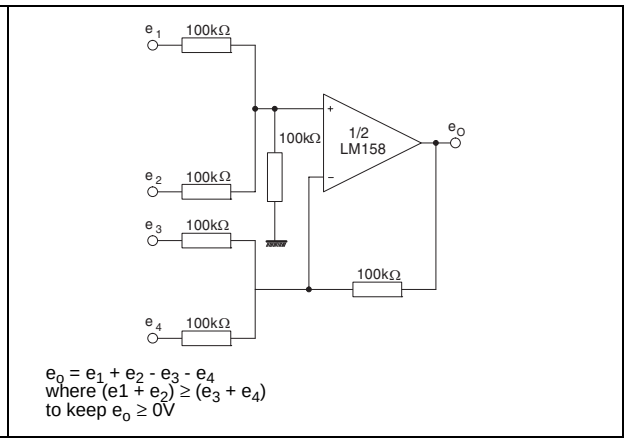
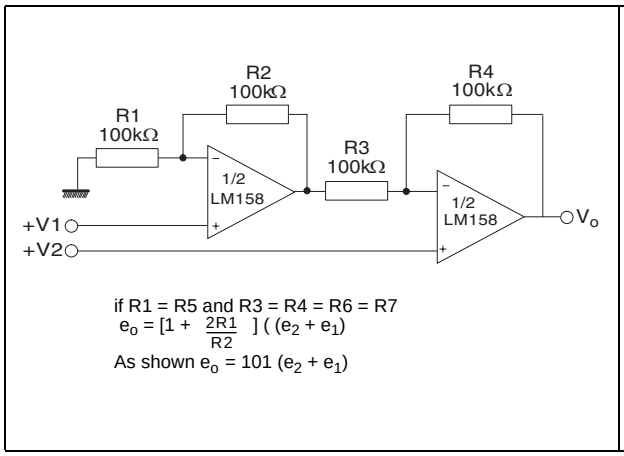


Figure 22. DC summing amplifier



$e_0 = e_1 + e_2 - e_3 - e_4$
where $(e1 + e_2) \geq (e_3 + e_4)$
to keep $e_o \geq 0V$

Figure 23. High input Z, DC differential amplifier

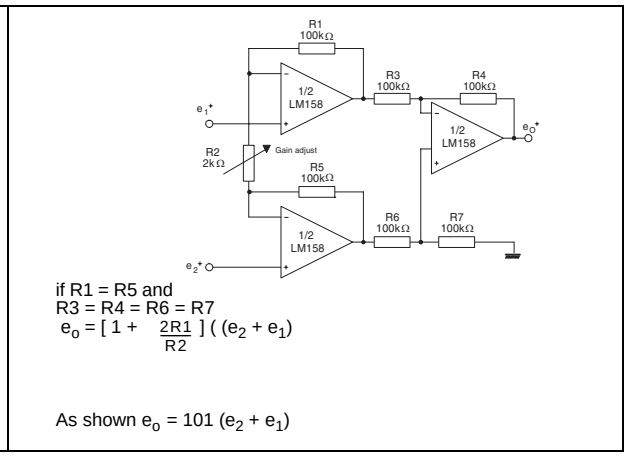


if R1 = R5 and R3 = R4 = R6 = R7

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

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

Figure 24. High input Z adjustable gain DC instrumentation amplifier



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

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

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

Figure 25. Using symmetrical amplifiers to reduce input current

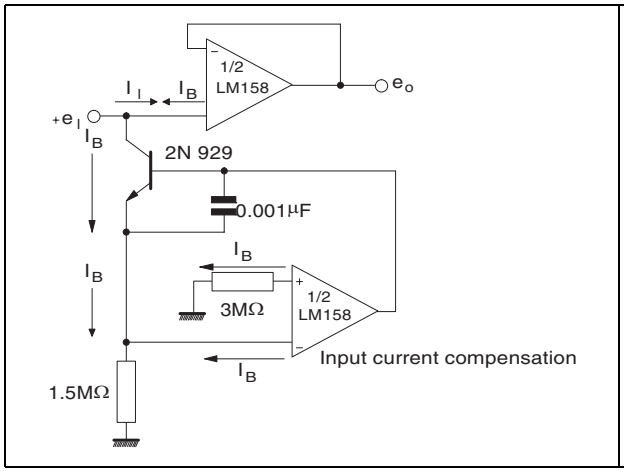


Figure 26. Low drift peak detector

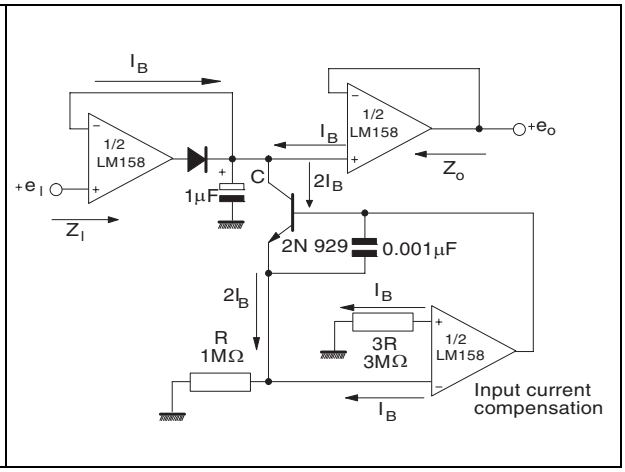
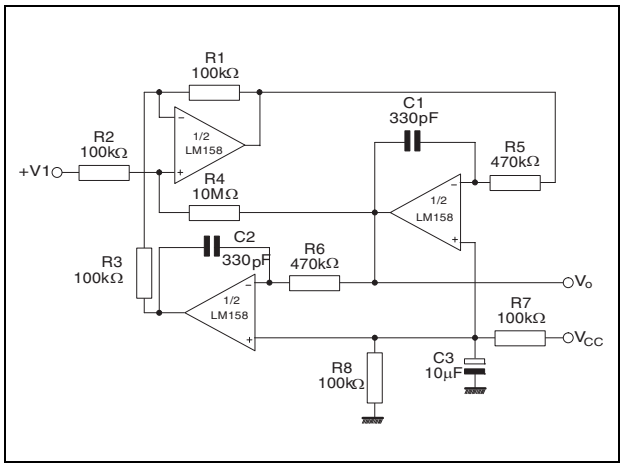


Figure 27. Active band-pass filter

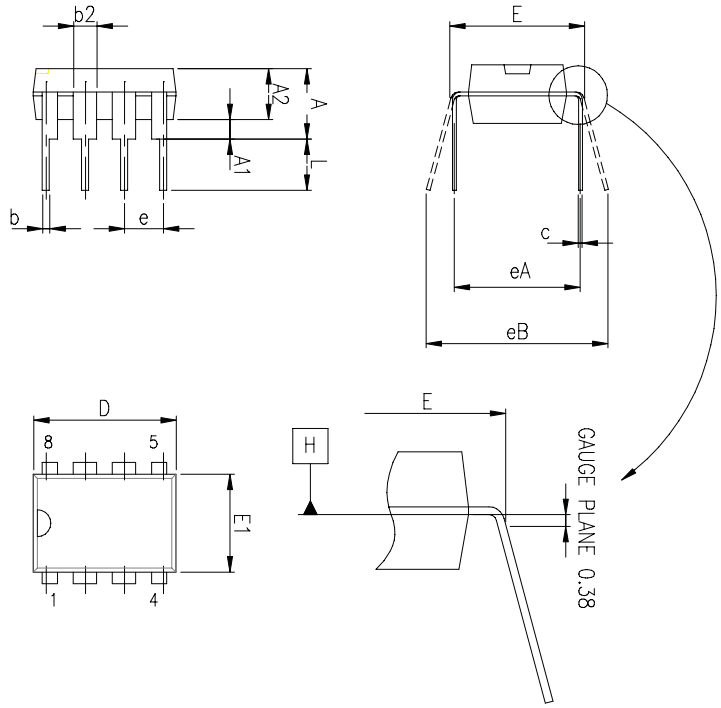


6 Package information

In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: www.st.com.

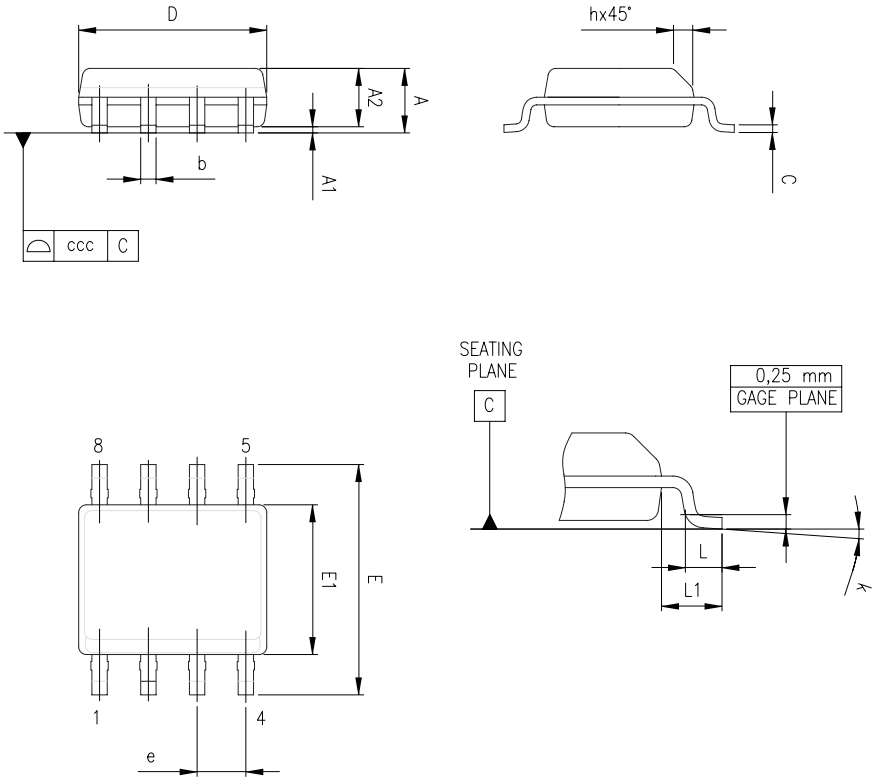
6.1 DIP8 package

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			5.33			0.210
A1	0.38			0.015		
A2	2.92	3.30	4.95	0.115	0.130	0.195
b	0.36	0.46	0.56	0.014	0.018	0.022
b2	1.14	1.52	1.78	0.045	0.060	0.070
c	0.20	0.25	0.36	0.008	0.010	0.014
D	9.02	9.27	10.16	0.355	0.365	0.400
E	7.62	7.87	8.26	0.300	0.310	0.325
E1	6.10	6.35	7.11	0.240	0.250	0.280
e		2.54			0.100	
eA		7.62			0.300	
eB			10.92			0.430
L	2.92	3.30	3.81	0.115	0.130	0.150



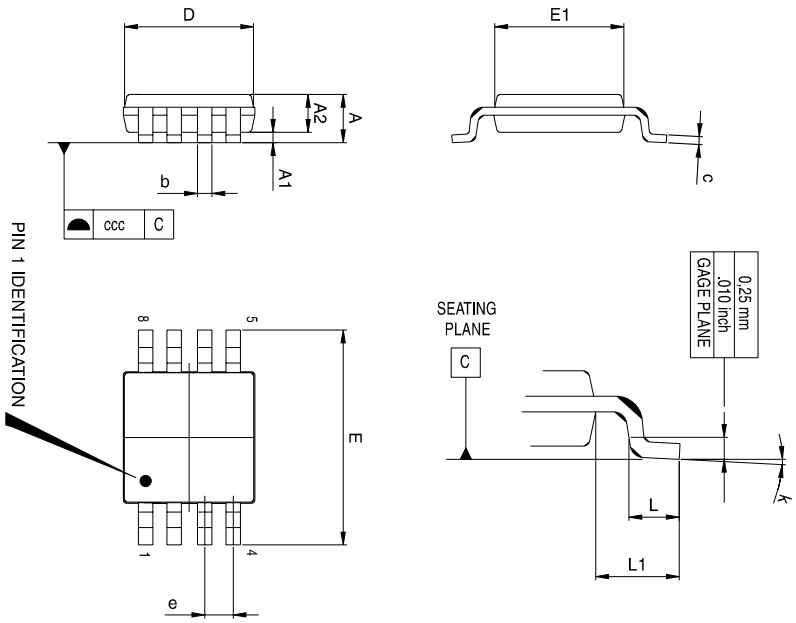
6.2 SO-8 package

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	1°		8°	1°		8°
ccc			0.10			0.004



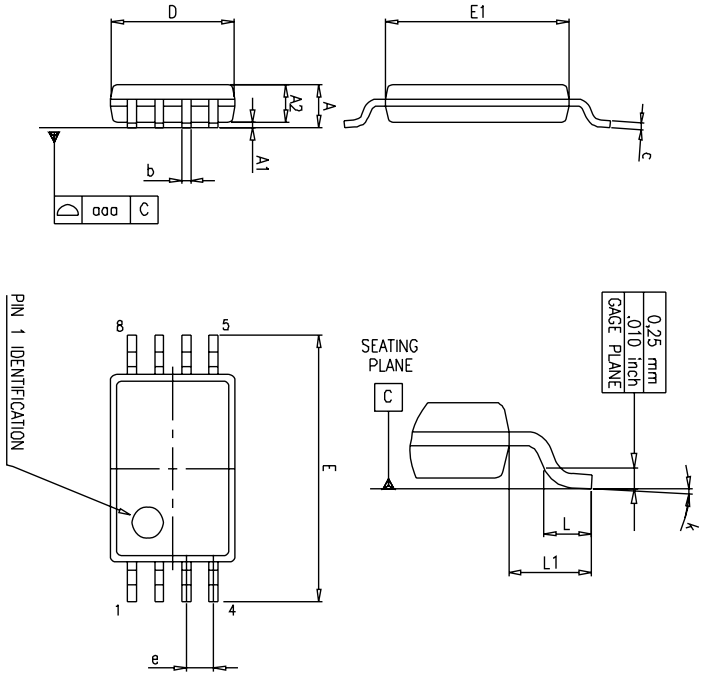
6.3 MiniSO-8 package

Ref.	Dimensions					
	Millimeters			Inches		
	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	0.034	0.037
b	0.25	0.33	0.40	0.010	0.013	0.016
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	0.114	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



6.4 TSSOP8 package

Ref.	Dimensions					
	Millimeters			Inches		
	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	
aaa		0.1			0.004	



7 Ordering information

Part number	Temperature range	Package	Packaging	Marking
LM158N	-55°C, +125°C	DIP-8	Tube	LM158N
LM158D LM158DT		SO-8	Tube or tape & reel	158
LM158YD LM158YDT(1)		SO-8 Automotive grade		158Y
LM258AN	-40°C, +105°C	DIP-8	Tube	LM258A
LM258AD LM258ADT		SO-8	Tube or tape & reel	258A
LM258AYD LM258AYDT(1)		SO-8 Automotive grade		258AY
LM258PT		TSSOP-8 (Thin shrink outline package)	Tape & reel	258
LM258APT				258A
LM258YPT(1)		TSSOP-8 Automotive grade		258Y
LM258AYPT				258AY
LM258AST		miniSO-8	Tape & reel	K408
LM258N		DIP-8	Tube	LM258N
LM258D LM258DT		SO-8	Tube or tape & reel	258
LM258YD LM258YDT(1)		SO-8 Automotive grade		258Y
LM358N	0°C, +70°C	DIP-8	Tube	LM358N
LM358AN				LM358AN
LM358D LM358DT		SO-8	Tube or tape & reel	358
LM358YD LM358YDT(1)		SO-8 Automotive grade		358Y
LM358AD LM358ADT		SO-8		358A
LM358PT		TSSOP-8 (Thin shrink outline package)	Tape & reel	358
LM358APT				358A
LM358YPT(1)		TSSOP-8 Automotive grade		358Y
LM358AYPT(1)				358AY
LM358ST		miniSO-8	Tape & reel	K405
LM358AST				K404

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent.

8 Revision history

Date	Revision	Changes
1-Jul- 2003	1	First release.
2-Jan-2005	2	R_{thja} and T_j parameters added in AMR *Table 1 on page 4*.
1-Jul-2005	3	ESD protection inserted in *Table 1 on page 4*.
5-Oct-2006	4	Added *Figure 18: Phase margin vs capacitive load*.
30-Nov-2006	5	Added missing ordering information.
25-Apr-2007	6	Removed LM158A, LM258A and LM358A from document title. Corrected error in miniSO8 package data. L1 is 0.004 inch. Added automotive grade order codes in *Section 7 on page 18*.

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