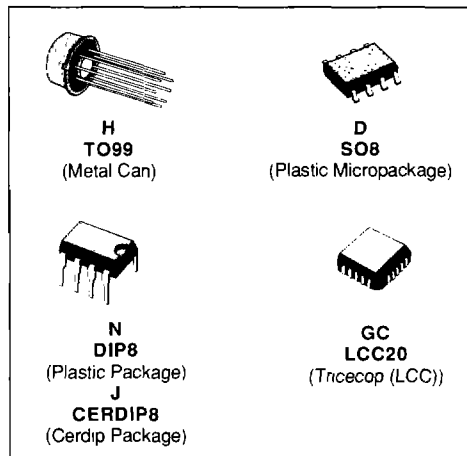


## LOW POWER DUAL OPERATIONAL AMPLIFIERS

- INTERNALLY FREQUENCY COMPENSATED.
- LARGE DC VOLTAGE GAIN : 100 dB
- WIDE BANDWIDTH (unity gain) : 1.1 MHz (temperature compensated)
- VERY LOW SUPPLY CURRENT/AMPLI (500  $\mu$ A) - 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 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 operated off the standard + 5 V power supply voltage 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 through operated from only a single power supply voltage.

The gain-bandwidth product is temperature compensated.

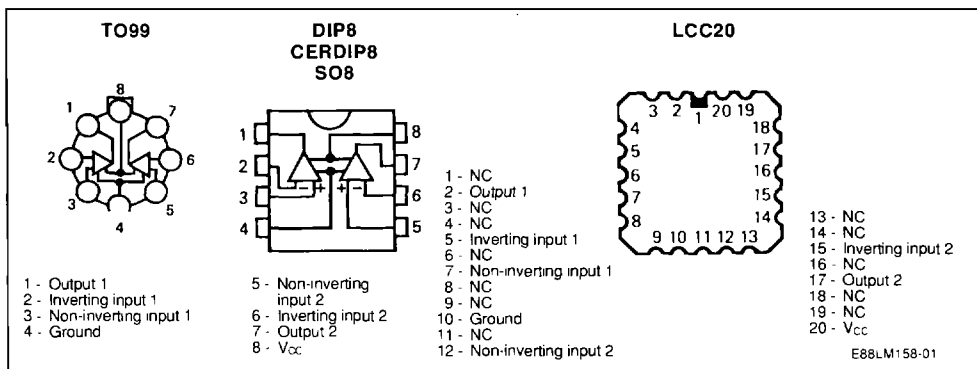
The input bias current is temperature compensated.

### ORDER CODES

Part Number	Temperature Range	Package				
		H	N	J	GC	D
<b>LM158, A</b>	- 55 °C to + 125 °C	•	•	•	•	•
<b>LM258, A</b>	- 40 °C to + 105 °C	•	•	•		•
<b>LM358, A</b>	0 °C to + 70 °C	•	•	•		•
<b>NE532</b>	0 °C to + 70 °C		•	•		•
<b>LM2904</b>	- 40 °C to + 105 °C		•	•		•

**Note :** Hi-Rel Versions Available  
**Examples :** LM158H, LM258N, LM2904D.

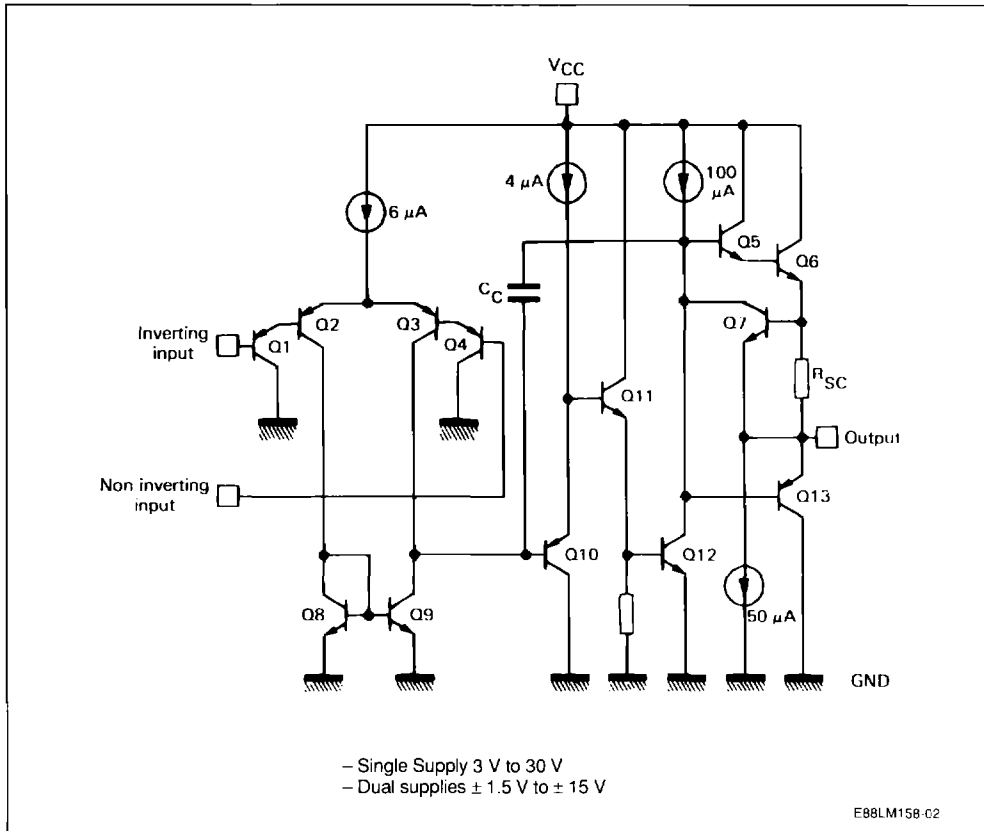
PIN CONNECTIONS (top views)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	LM158, A	LM258, A LM2904	LM358, A NE532	Unit
V <sub>CC</sub>	Supply Voltage	+ 32	+ 32	+ 32	V
V <sub>I</sub>	Input Voltage	- 0.3 to + 32	- 0.3 to + 32	- 0.3 to + 32	V
V <sub>ID</sub>	Differential Input Voltage	+ 32	+ 32	+ 32	V
	Output Short-circuit Duration (note 2)	Indefinite	Indefinite	Indefinite	
P <sub>tot</sub>	Power Dissipation	500 665	500	500	mW
		LM158GC			
I <sub>ID</sub>	Input Current (note 1)	50	50	50	mA
T <sub>oper</sub>	Operating Free-air Temperature Range	- 55 to + 125	- 40 to + 105	0 to + 70	°C
T <sub>stg</sub>	Storage Temperature Range	- 65 to + 150	- 65 to + 150	- 65 to + 150	°C

**SCHEMATIC DIAGRAM** (1/2 LM158)



CASE	Inverting Inputs	Non-inverting Inputs	GND	V <sub>CC</sub>	Outputs	N.C.
TO99 - DIP8 - CERDIP8 - SO8	2-6	3-5	4	8	1-7	
LCC20	5-15	7-12	10	20	2-17	*

\* LCC20 : Other pins are not connected.

**ELECTRICAL CHARACTERISTICS**

$V_{CC} = +5\text{ V}$ ,  $V_{CC} = \text{Ground}$ ,  $V_O = 1.4\text{ V}$   
(unless otherwise specified)

LM358, A/NE532 :  $0 \leq T_{amb} \leq +70\text{ }^\circ\text{C}$   
 LM258, A/LM2904 :  $-40 \leq T_{amb} \leq +105\text{ }^\circ\text{C}$   
 LM158, A :  $-55 \leq T_{amb} \leq +125\text{ }^\circ\text{C}$

Symbol	Parameter	LM158A, LM258A LM358A			LM158, LM258 LM358, LM2904 NE532			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$V_{IO}$	Input Offset Voltage (note 3) $T_{amb} = 25\text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$		1	2 4		2	5 7	mV
$I_{IO}$	Input Offset Current $T_{amb} = 25\text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$		2	10 30		2	20 40	nA
$I_{IB}$	Input Bias Current (note 4) $T_{amb} = 25\text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$		20	50 100		20	100 200	nA
$A_{VD}$	Large Signal Voltage Gain ( $V_{CC} = +15\text{ V}$ , $R_L \geq 2\text{ k}\Omega$ ) ( $V_O = 1.4\text{ V}$ to $11.4\text{ V}$ ) $T_{amb} = 25\text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$	50 25	100		50 25	100		V/mV
SVR	Supply Voltage Rejection Ratio ( $R_S \leq 10\text{ k}\Omega$ ) $T_{amb} = 25\text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$	65 65	100		65 65	100		dB
$I_{CC}$	Supply Current, all Amp, no Load $T_{amb} = 25\text{ }^\circ\text{C}$ , $V_{CC} = +5\text{ V}$ $T_{amb} = 25\text{ }^\circ\text{C}$ , $V_{CC} = +30\text{ V}$ $T_{min} \leq T_{amb} \leq T_{max}$		0.7 1	1.2 2		0.7 1	1.2 2	mA
$V_I$	Input Voltage Range (note 6) $T_{amb} = 25\text{ }^\circ\text{C}$  $T_{min} \leq T_{amb} \leq T_{max}$	0 0		$V_{CC} - 1.5$ $V_{CC} - 2$	0 0		$V_{CC} - 1.5$ $V_{CC} - 2$	V
CMR	Common-mode Rejection Ratio ( $R_S < 10\text{ k}\Omega$ ) (note 3) $T_{amb} = 25\text{ }^\circ\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$	70 60	85		70 60	85		dB
$I_O$	Output Short-circuit Current ( $V_I = +1\text{ V}$ , $V_I = 0\text{ V}$ ) $T_{amb} = 25\text{ }^\circ\text{C}$ , $V_{CC} = +15\text{ V}$ (note 2) $T_{min} \leq T_{amb} \leq T_{max}$	20 10	40	60	20 10	40	60	mA
$I_{sink}$	Output Current Sink ( $V_I = -1\text{ V}$ , $V_I = 0\text{ V}$ ) $V_{CC} = +15\text{ V}$ $V_O = +0.2\text{ V}$							mA
	$T_{amb} = +25\text{ }^\circ\text{C}$	10	20		10	20		mA
	$T_{min} \leq T_{amb} \leq T_{max}$	10			10			mA
	$T_{amb} = +25\text{ }^\circ\text{C}$	12	50		12	50		$\mu\text{A}$
	$T_{min} \leq T_{amb} \leq T_{max}$	12			12			$\mu\text{A}$

## ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	LM158A, LM258A LM358A			LM158, LM258 LM358, LM2904 NE532			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V <sub>OPP</sub>	Output Voltage Swing T <sub>amb</sub> = 25 °C R <sub>L</sub> ≥ 2 kΩ	0		V <sub>CC</sub> - 1.5	0		V <sub>CC</sub> - 1.5	V
	T <sub>min</sub> ≤ T <sub>amb</sub> ≤ T <sub>max</sub> R <sub>L</sub> ≥ 10 kΩ	0		V <sub>CC</sub> - 2	0		V <sub>CC</sub> - 2	
V <sub>OH</sub>	High Level Output Voltage (V <sub>CC</sub> = 30 V) T <sub>amb</sub> = 25 °C R <sub>L</sub> = 2 kΩ	26	27		26	27		V
	T <sub>min</sub> ≤ T <sub>amb</sub> ≤ T <sub>max</sub> T <sub>amb</sub> = 25 °C R <sub>L</sub> = 10 kΩ	26	28		26	28		
	T <sub>min</sub> ≤ T <sub>amb</sub> ≤ T <sub>max</sub>	27			27			
	T <sub>min</sub> ≤ T <sub>amb</sub> ≤ T <sub>max</sub>	27			27			
V <sub>OL</sub>	Low Level Output Voltage (R <sub>L</sub> ≥ 10 kΩ) T <sub>amb</sub> = 25 °C T <sub>min</sub> ≤ T <sub>amb</sub> ≤ T <sub>max</sub>		5	20 20		5	20 20	mV
S <sub>VO</sub>	Slew-rate (V <sub>I</sub> = 0.5 to 3 V, R <sub>L</sub> = 2 kΩ C <sub>L</sub> ≤ 100 pF, T <sub>amb</sub> = 25 °C, unity gain) V <sub>CC</sub> = 15 V	0.3	0.6		0.3	0.6		V/μs
GBP	Gain Bandwidth Product (f = 100 kHz, T <sub>amb</sub> = 25 °C, V <sub>CC</sub> = 30 V V <sub>IN</sub> = 10 mV, R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF)	0.7	1.1	1.6	0.7	1.1	1.6	MHz
THD	Total Harmonic Distortion (f = 1 kHz, A <sub>v</sub> = 20 dB, R <sub>L</sub> = 2 kΩ, V <sub>CC</sub> = 30 V C <sub>L</sub> ≤ 100 pF, T <sub>amb</sub> = 25 °C, V <sub>O</sub> = 2 V <sub>PP</sub> )		0.02			0.02		%
V <sub>n</sub>	Equivalent Input Noise voltage (f = 1 kHz, R <sub>g</sub> = 100 Ω, V <sub>CC</sub> = 30 V)		55			55		nV/√Hz
DV <sub>io</sub>	Input Offset Voltage Drift T <sub>min</sub> ≤ T <sub>amb</sub> ≤ T <sub>max</sub>		7	30		7	30	μV/°C
DI <sub>io</sub>	Input Offset Current Drift T <sub>min</sub> ≤ T <sub>amb</sub> ≤ 25 °C		10	300		10	300	pA/°C
V <sub>O1</sub> /V <sub>O2</sub>	Channel Separation (note 5) 1 kHz ≤ f ≤ 20 kHz		120			120		dB

**Notes :** 1. This input only exist 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<sub>CC</sub> voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative.

This is not destructive and normal output will set up again for input voltage higher than - 0.3V.

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

3. V<sub>O</sub> = 1.4V, R<sub>S</sub> = 0, 5V < V<sub>CC</sub> < 30V, 0 < V<sub>I</sub> < V<sub>CC</sub> - 1.5V.

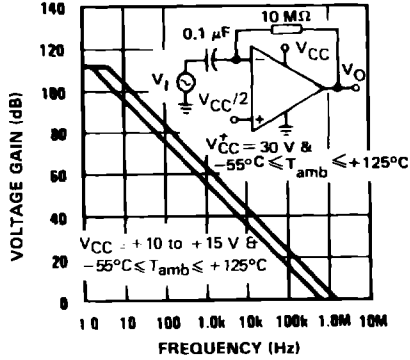
4. The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.

5. 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 frequencies.

6. 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<sub>CC</sub> - 1.5V.

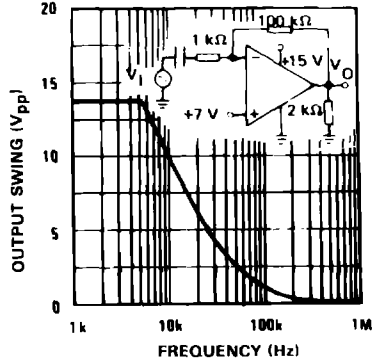
But either or both inputs can go to + 32V without damage.

OPEN LOOP FREQUENCY RESPONSE (Note 3)



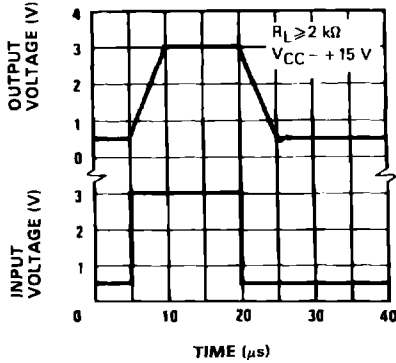
E88LM158-03

LARGE SIGNAL FREQUENCY RESPONSE



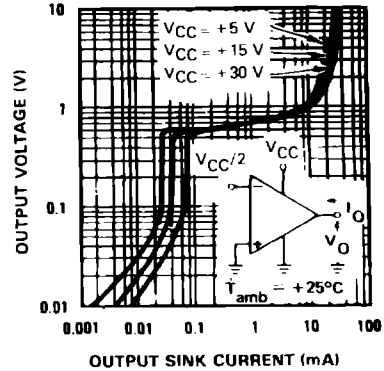
E88LM158-04

VOLTAGE FOLLOWER PULSE RESPONSE



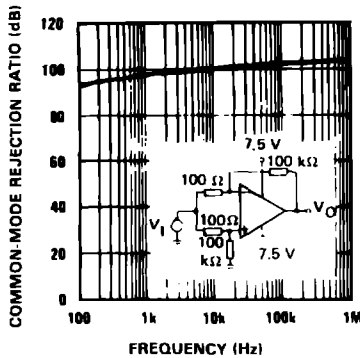
E88LM158-05

OUTPUT CHARACTERISTICS



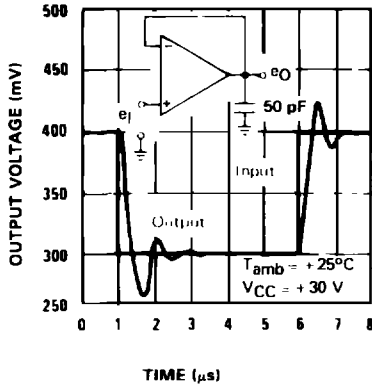
E88LM158-06

COMMON-MODE REJECTION RATIO



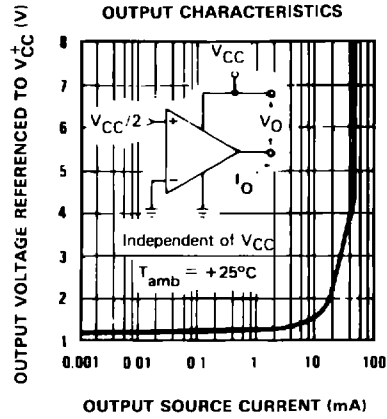
E88LM158-07

VOLTAGE FOLLOWER PULSE RESPONSE (SMALL SIGNAL)



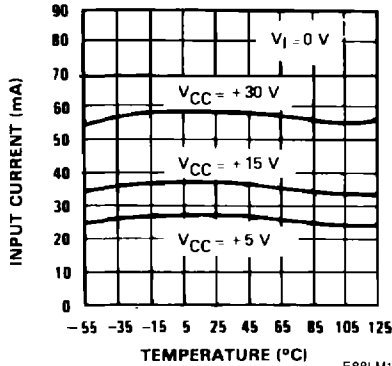
E88LM158-08

OUTPUT CHARACTERISTICS



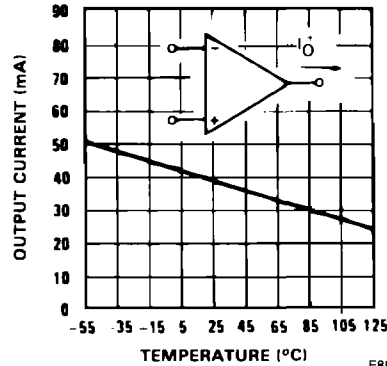
E88LM158-09

INPUT CURRENT (Note 1)



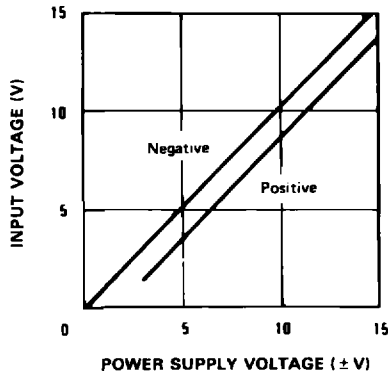
E88LM158-10

CURRENT LIMITING (Note 1)



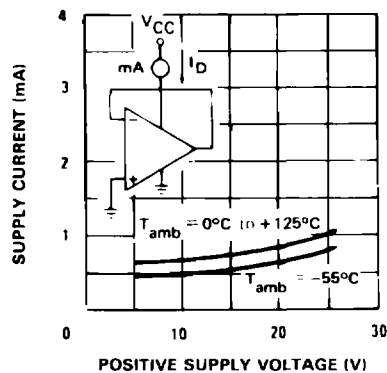
E88LM158-11

INPUT VOLTAGE RANGE

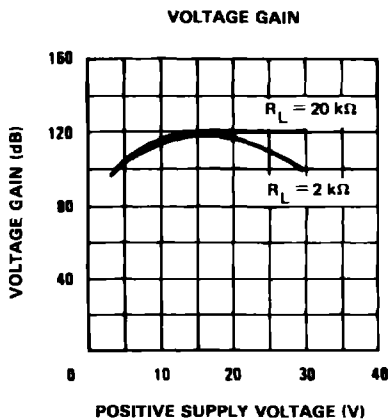


E88LM158-12

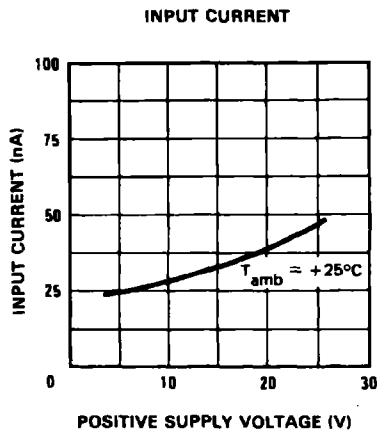
SUPPLY CURRENT



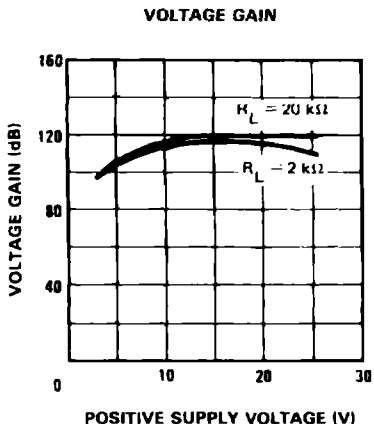
E88LM158-13



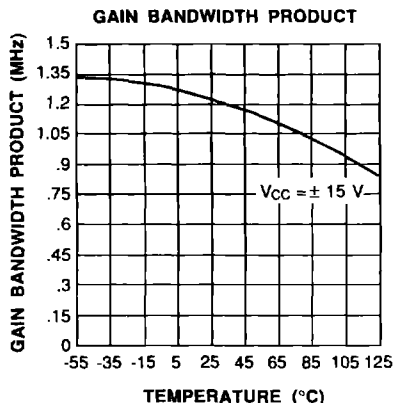
E88LM158-14



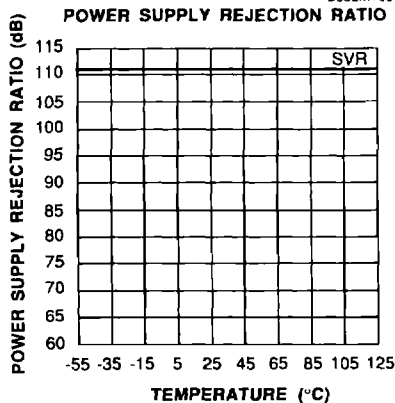
E88LM158-15



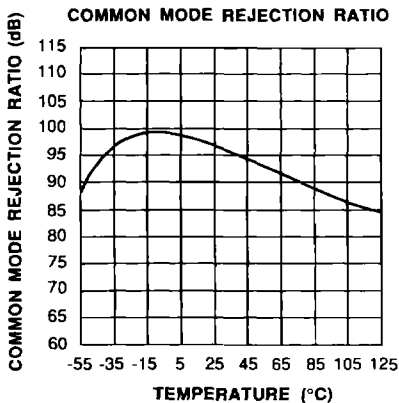
E88LM158-16



E88LM158-17



E88LM158-18

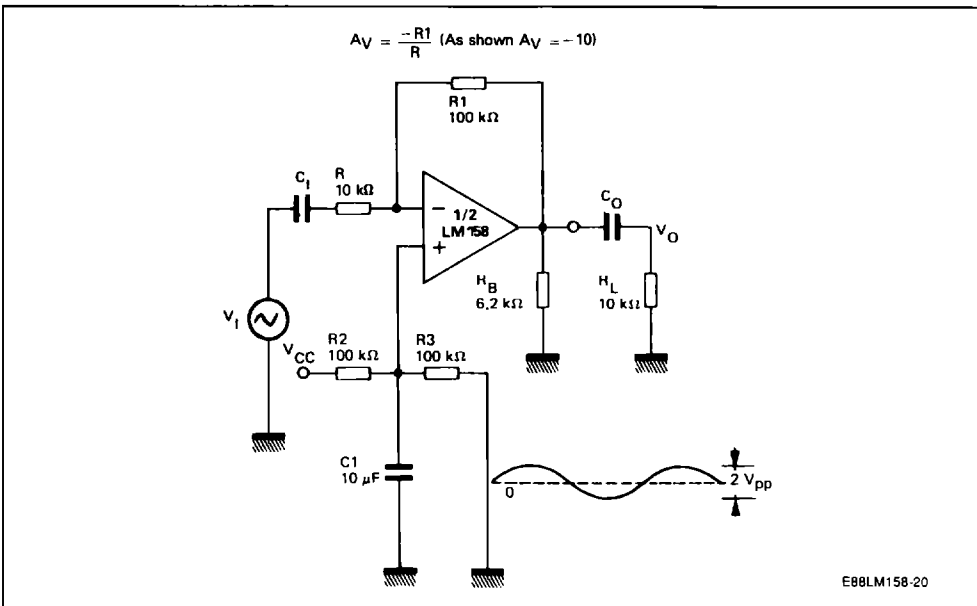


E88LM158-19

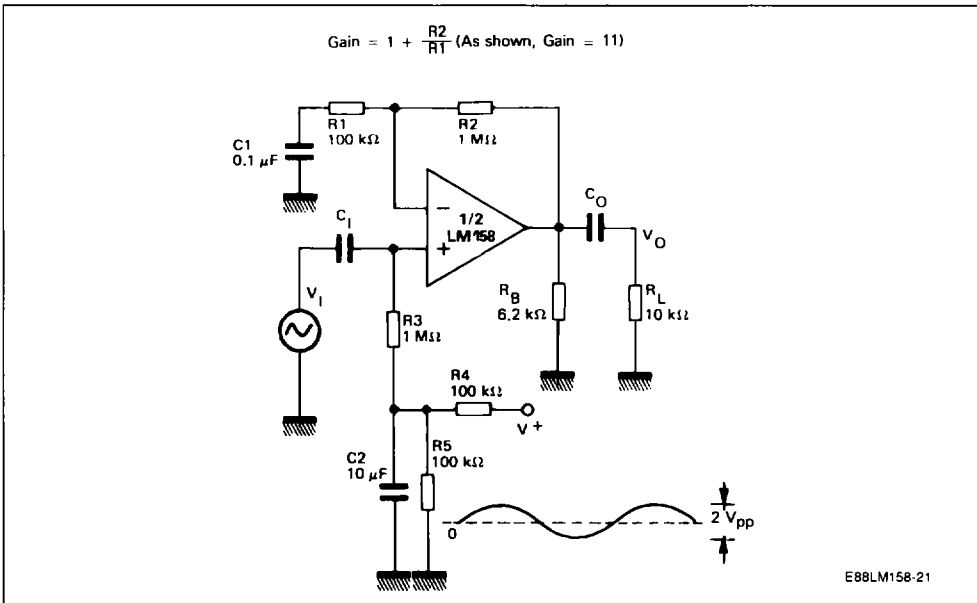


**TYPICAL APPLICATIONS** (single supply voltage)  $V_{CC} = +5\text{ V}_{DC}$

**AC COUPLED INVERTING AMPLIFIER**

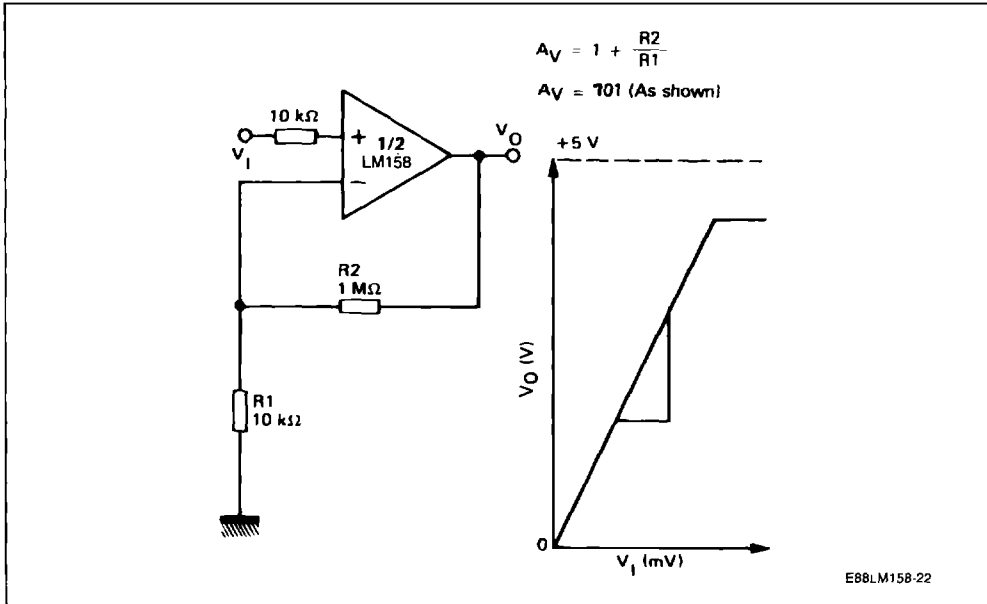


**AC COUPLED NON INVERTING AMPLIFIER**

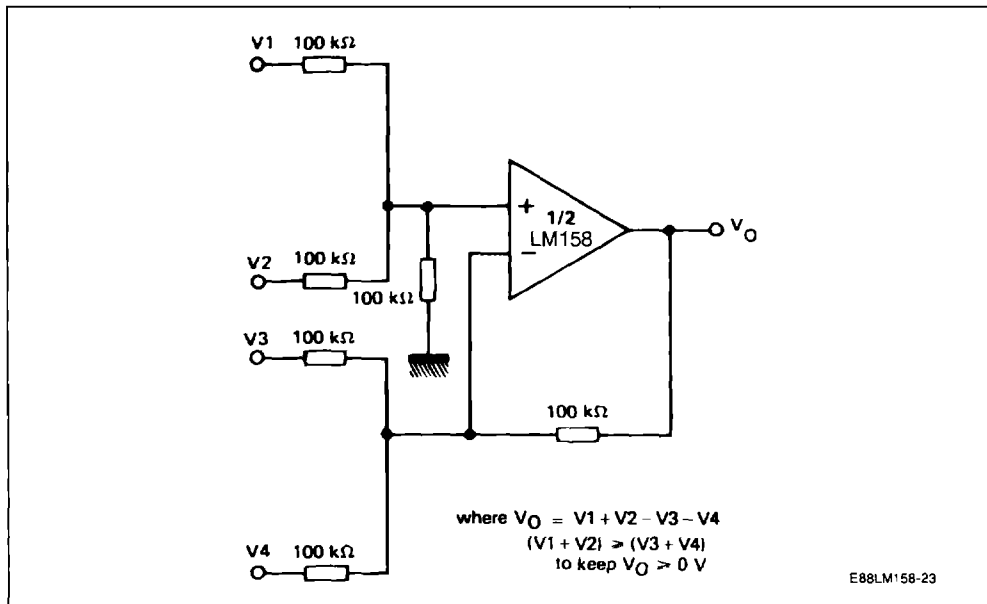


TYPICAL APPLICATIONS (single supply voltage)  $V_{CC} = +5 V_{DC}$  (continued)

NON INVERTING DC AMPLIFIER

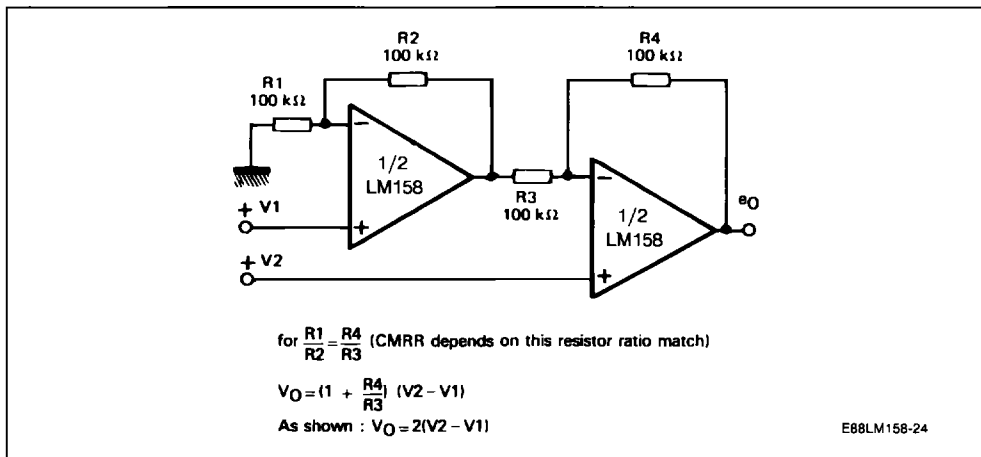


DC SUMMING AMPLIFIER

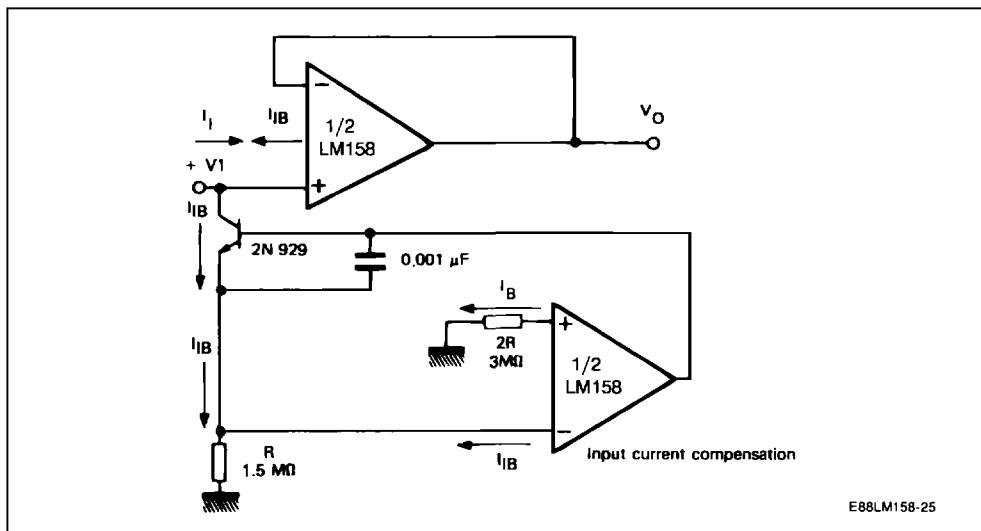


TYPICAL APPLICATIONS (single supply voltage)  $V_{CC} = +5 V_{DC}$  (continued)

## HIGH INPUT IMPEDANCE, DC DIFFERENTIAL AMPLIFIER

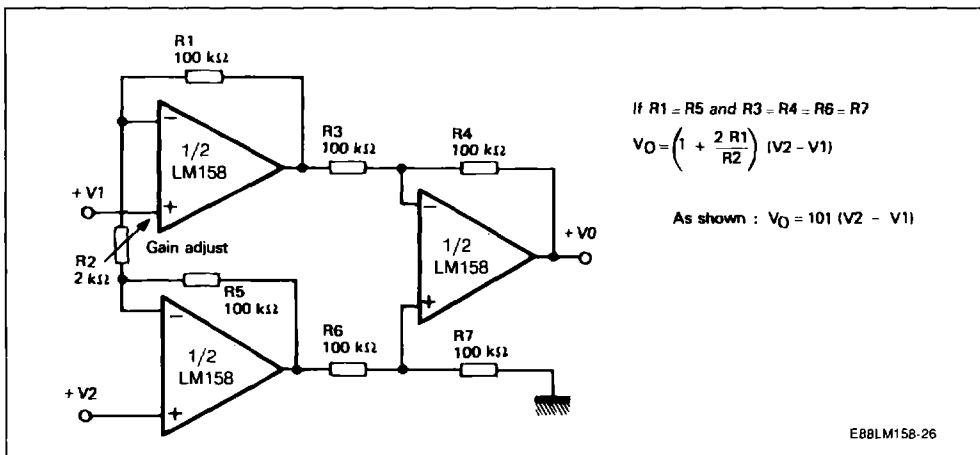


## USING SYMMETRICAL AMPLIFIERS TO REDUCE INPUT CURRENT (general concept)

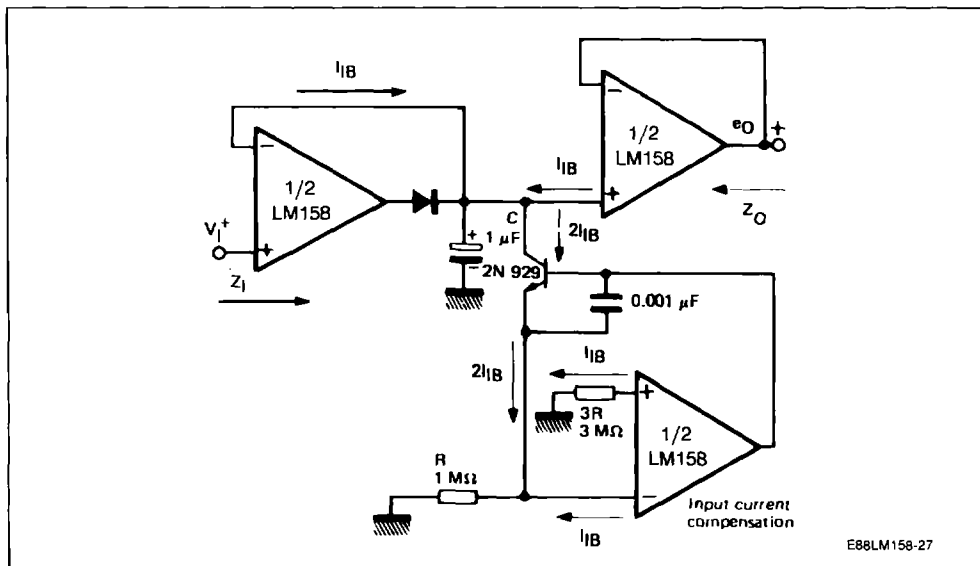


TYPICAL APPLICATIONS (single supply voltage)  $V_{CC} = +5 V_{DC}$  (continued)

HIGH INPUT Z ADJUSTABLE-GAIN DC INSTRUMENTATION AMPLIFIER

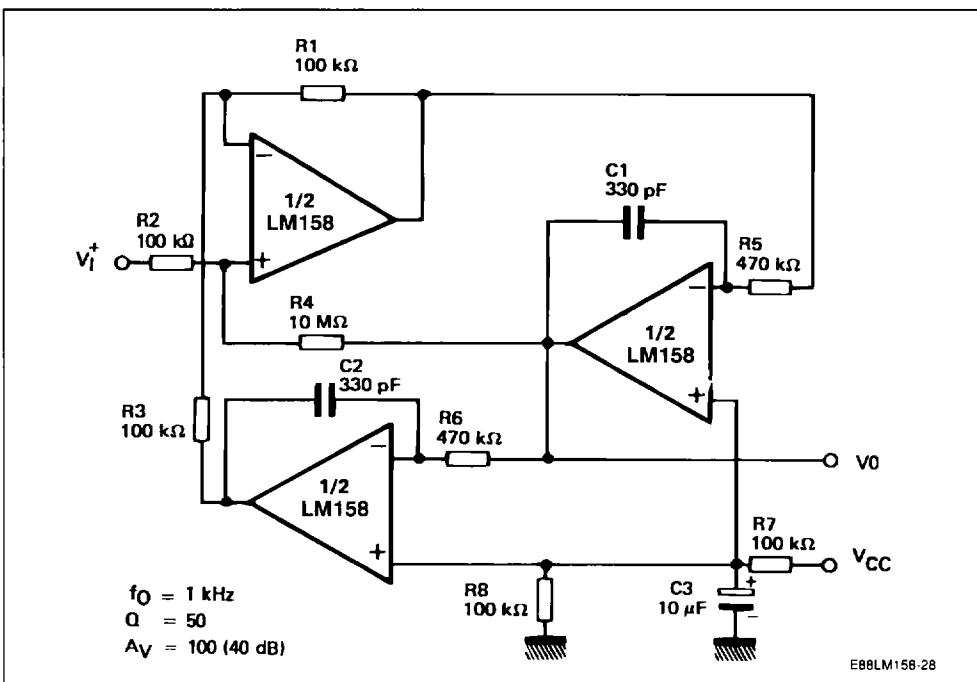


LOW DRIFT PEAK DETECTOR



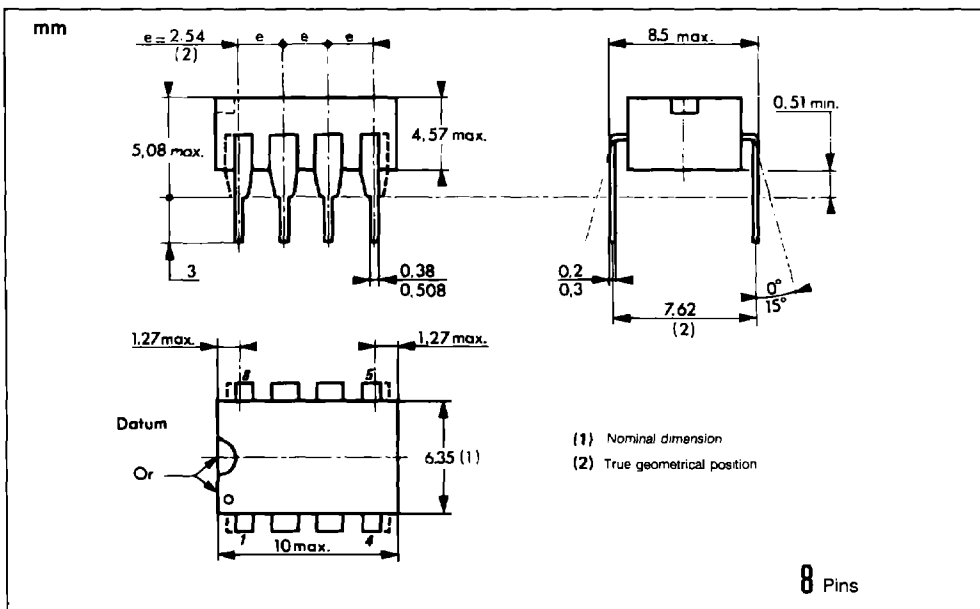
TYPICAL APPLICATIONS (single supply voltage)  $V_{CC} = +5 V_{DC}$  (continued)

## ACTIVE BAND-PASS FILTER

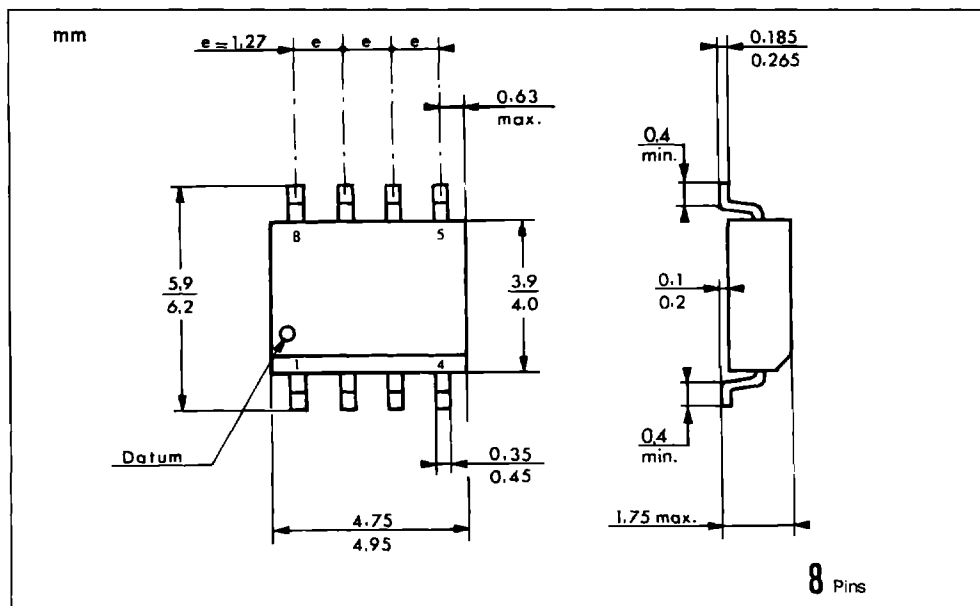


PACKAGE MECHANICAL DATA

8 PINS - PLASTIC DIP OR CERDIP

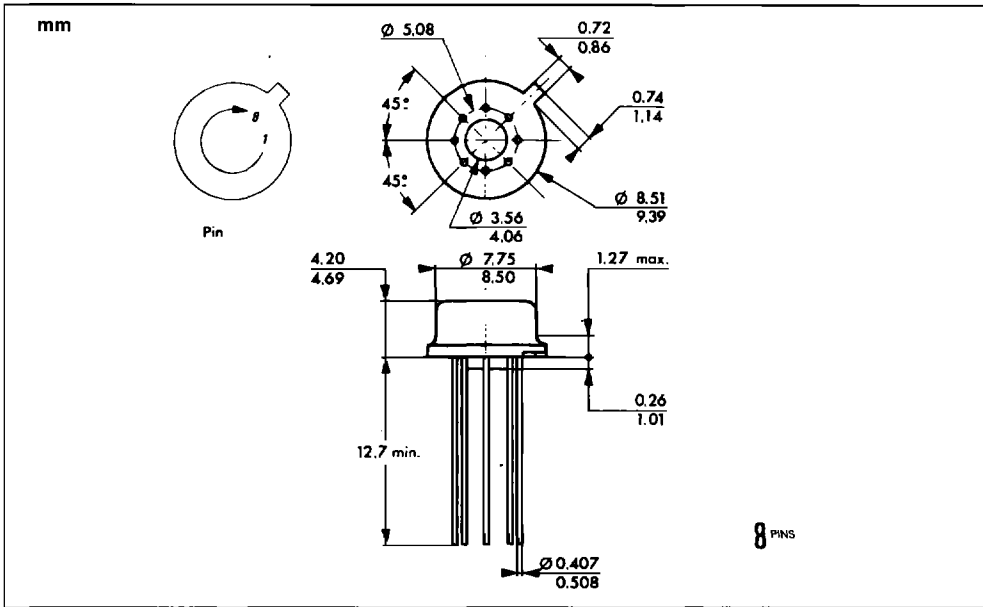


8 PINS - PLASTIC MICROPACKAGE (SO)



PACKAGE MECHANICAL DATA (continued)

8 PINS – METAL CAN - TO99



20 PINS – TRICECOP (LCC)

