1. DESCRIPTION

These circuits consist of two independent, high- gain, internally frequency-compensated op-amps, specifically designed 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 can now 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 with no 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.

2. 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 negative rails
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0 V to (V_{CC}^+ -1.5 V)

3. SCHEMATIC DIAGRAM AND PIN DEFINITION DIAGRAM

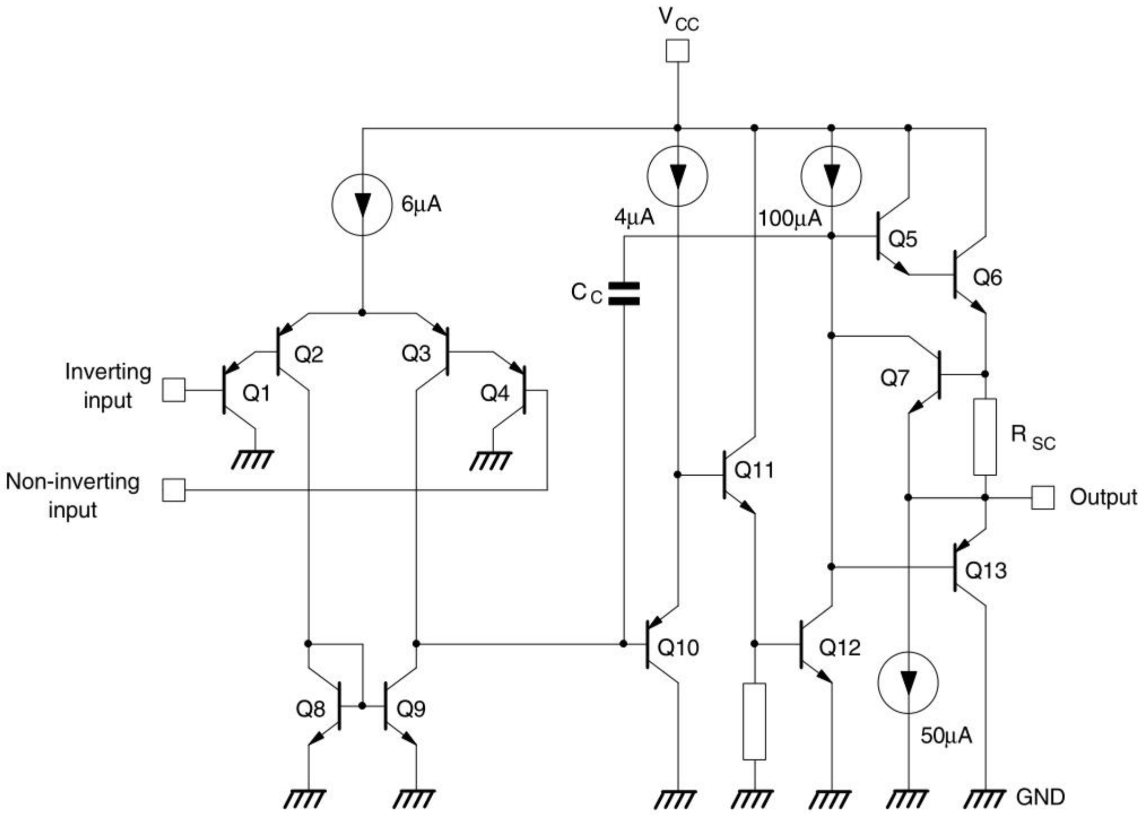
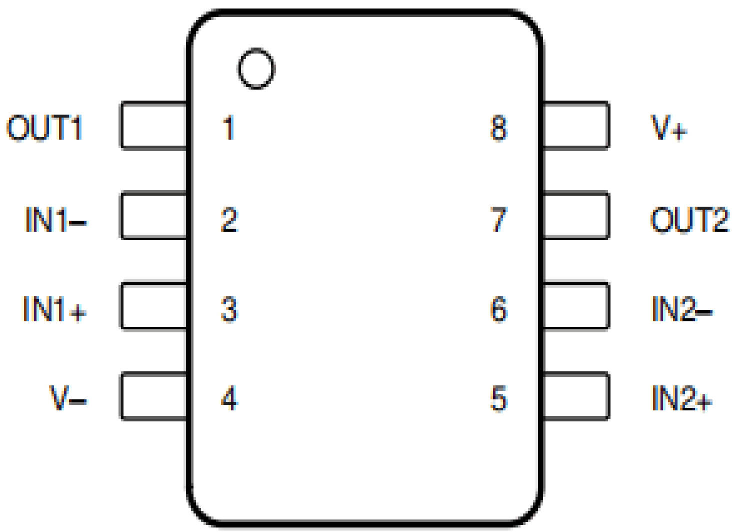


Figure 1. Schematic diagram



4. ABSOLUTE MAXIMUM RATINGS

Table 1. Absolute maximum ratings

Symbol	Parameter	XL158	Unit
V_{CC}	Supply voltage	+/-16 or 32	V
V_i	Input voltage	32	V
V_{id}	Differential input voltage	32	V
	Output short-circuit duration (1)	Infinite	
I_{in}	Input current (2)	5 mA in DC or 50 mA in AC (duty cycle = 10%, T=1s)	mA
T_{oper}	Operating free-air temperature range	-40 to +105	°C
T_{stg}	Storage temperature range	-65 to +150	°C
T_j	Maximum junction temperature	150	°C
R_{thja}	Thermal resistance junction to ambient(3) SOP8	125	°C/W
R_{thjc}	Thermal resistance junction to case (3) SOP8	40	°C/W
ESD	HBM: human body model(4)	300	V
	MM: machine model(5)	200	V
	CDM: charged device model(6)	1.5	kV

1. Short-circuits from the output to VCC can cause excessive heating if VCC > 15 V. The maximum output current is approximately 40 mA independent of the magnitude of VCC. Destructive dissipation can result from simultaneous short circuits on all amplifiers.
2. 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 clamp. In addition to this diode action, there is NPN parasitic action on the IC chip. This transistor action can cause the output voltages of the Op-amps to go to the VCC voltage level (or to ground for a large
3. overdrive) for the time during which an input is driven negative.
4. This is not destructive and normal output is restored for input voltages above -0.3 V.
5. Short-circuits can cause excessive heating and destructive dissipation. Rth are typical values.
6. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a
7. 1.5 kW resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
8. Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 W). This is done for all couples of connected pin combinations while the other pins are floating.
9. 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.

5. OPERATING CONDITIONS

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	3 to 30	V
V_{icm}	Common mode input voltage range(1)	V_{CC}^{-} -0.3 to V_{CC}^{+} -1.5	V
T_{oper}	Operating free air temperature range XL158	-40 to +105	℃

1. When used in comparator, the functionality is guaranteed as long as at least one input remains within the operating common mode voltage range.

6. ELECTRICAL CHARACTERISTICS

Table 3. Electrical characteristics for V_{CC}^{+} = +5 V, V_{CC}^{-} = Ground, V_o = 1.4 V, T_{amb} = +25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage (1) XL158 XL158			 2 5	mV
	T_{min} £ T_{amb} £ T_{max} XL158 XL158			 4 7	
DV_{io}	Input offset voltage drift XL158 XL158		 7 7	 15 30	µV/°C
I_{io}	Input offset current XL158 XL158 T_{min} £ T_{amb} £ T_{max} XL158 XL158		 2 2	 10 30 30 40	nA
DI_{io}	Input offset current drift XL158 XL158		 10 10	 200 300	pA/°C
I_{ib}	Input bias current (2) XL158 XL158 T_{min} £ T_{amb} £ T_{max} XL158 XL158		 20 20	 50 150 100 200	nA
A_{vd}	Large signal voltage gain VCC^{+}= +15 V, RL= 2 kW, V = 1.4 V to 11.4 V T_{min} £ T_{amb} £ T_{max}	50 25	100		V/mV
SVR	Supply voltage rejection ratio VCC^{+} = 5 V to 30 V, RS£ 10 kW T_{min} £ T_{amb} £ T_{max}	65 65	100		dB
I_{CC}	Supply current, all amp, no load T_{min} £ T_{amb} £ T_{max} V_{CC}^{+} = +5 V Tmin £ Tamb £ Tmax V_{CC}^{+} = +30 V		0.7	1.2 2	mA
V_{icm}	Input common mode voltage range VCC^{+}= +30 V T_{min} £ T_{amb} £ T_{max}	0 0		V_{CC}^{+} -1.5 V_{CC}^{+} -2	V

Table 3. Electrical characteristics for V_{CC}^{+} = +5 V, V_{CC}^{-} = Ground, V_o = 1.4 V, T_{amb} = +25°C (unless otherwise specified) (continued)

Symbol	Parameter	Min.	Typ.	Max.	Unit
CMR	Common mode rejection ratio R_s £ 10 kW T_{min} £ T_{amb} £ T_{max}	70 60	85		dB
I_{source}	Output current source V_{CC}^{+} = +15 V, V_O= +2 V, V_{ID}= +1 V	20	40	60	mA
I_{sink}	Output sink current V_{CC}^{+} = +15 V, V_o = +2 V, V_{id} = -1 V V_{CC}^{+} = +15 V, V_o = +0.2 V, V_{id} = -1 V	10 12	20 50		mA µA
V_{OH}	High level output voltage R_L = 2 kW, V_{CC}+ = 30 V T_{min} £ T_{amb} £ T_{max} R_L = 10kW, V_{CC}+ = 30 V T_{min} £ T_{amb} £ T_{max}	26 26 27 27	27 28		V
V_{OL}	Low level output voltage R_L = 10 kW T_{min} £ T_{amb} £ T_{max}		5	20 20	mV
SR	Slew rate V_{CC}^{+} = 15 V, V_i = 0.5 to 3 V, R_L = 2 kW, C_L = 100 pF, unity gain	0.3	0.6		V/µs
GBP	Gain bandwidth product V_{CC}^{+} = 30 V, f = 100 kHz, V_{IN}= 10 mV, R_L = 2 kW, C_L = 100 pF	0.7	1.1		MHz
THD	Total harmonic distortion f = 1 kHz, A_v = 20 dB, R_L = 2 kW, V_o = 2 V_{pp}, C_L = 100 pF, V_O = 2 V_{pp}		0.02		%
e_n	Equivalent input noise voltage f = 1 kHz, R_s = 100 W, V_{CC}^{+} = 30 V		55		$\frac{nV}{\sqrt{Hz}}$
V_{o1}/V_{o2}	Channel separation(4) 1 kHz £ f £ 20 kHz		120		dB

1. V_o = 1.4 V, R_s = 0 W, 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.

7. ELECTRICAL CHARACTERISTICS CURVES

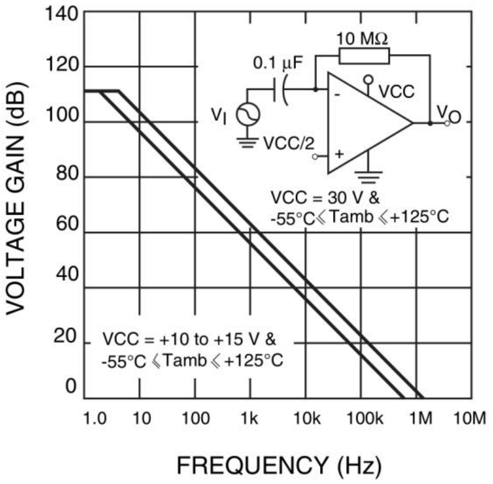


Figure 2. Open-loop frequency response

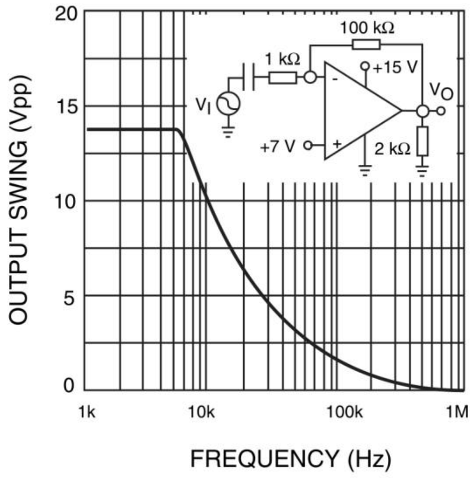


Figure 3. Large signal frequency response

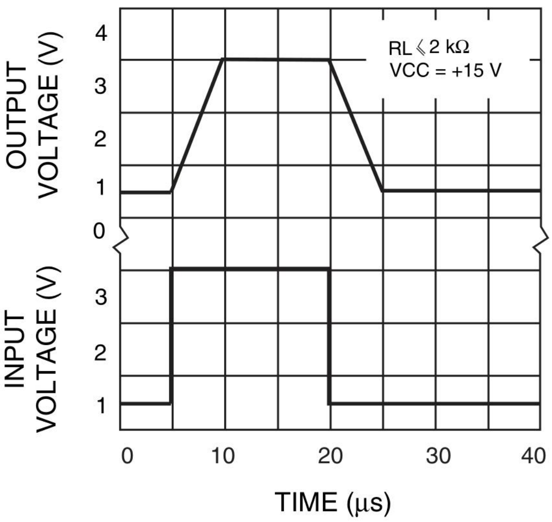


Figure 4. Voltage follower pulse response with VCC = 15 V

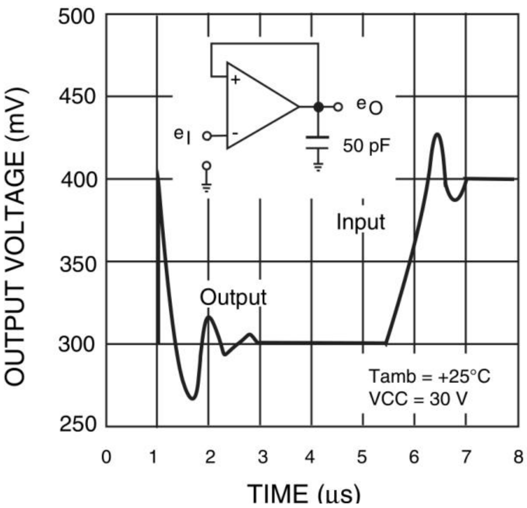


Figure 5. Voltage follower pulse response with VCC = 30 V

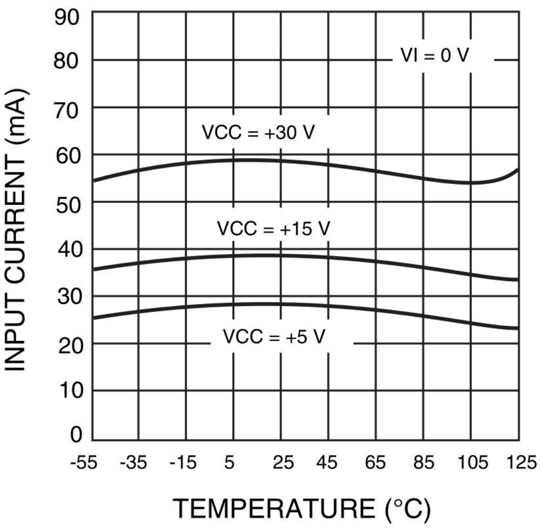


Figure 6. Input current

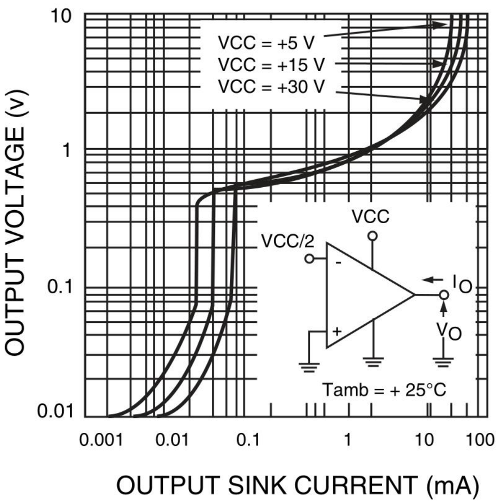


Figure 7. Output voltage vs sink current

8. TYPICAL APPLICATIONS

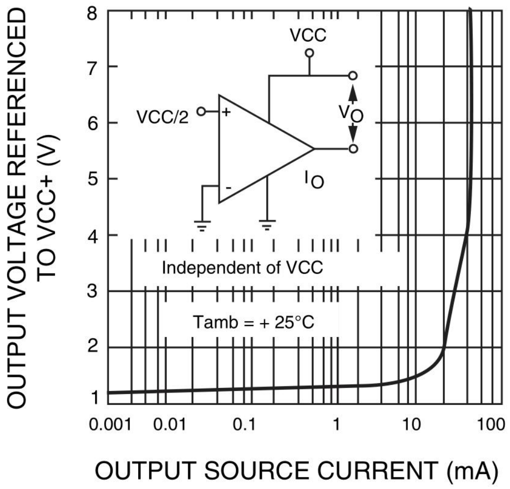


Figure 8. Output voltage vs source current

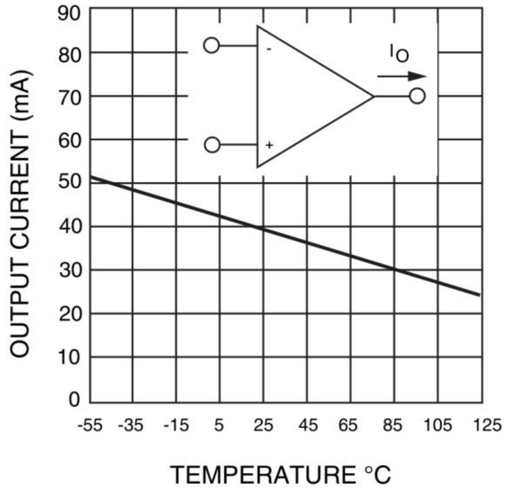


Figure 9. Current limiting

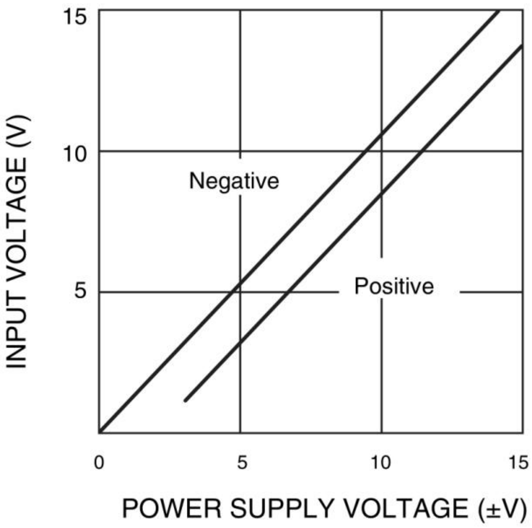


Figure 10. Input voltage range

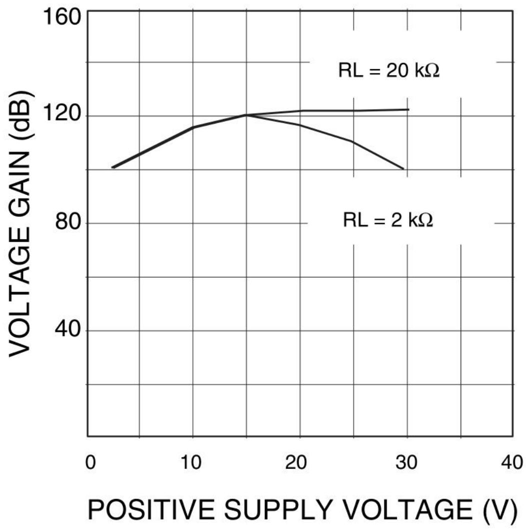


Figure 11. Open-loop gain

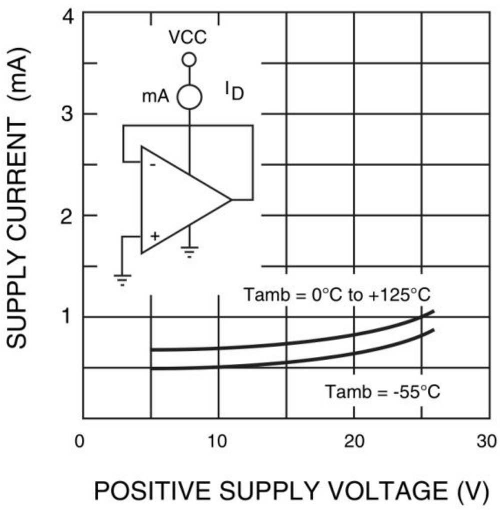


Figure 12. Supply current

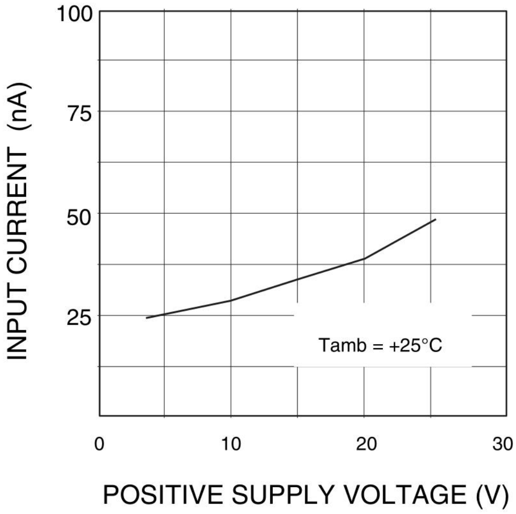


Figure 13. Input current

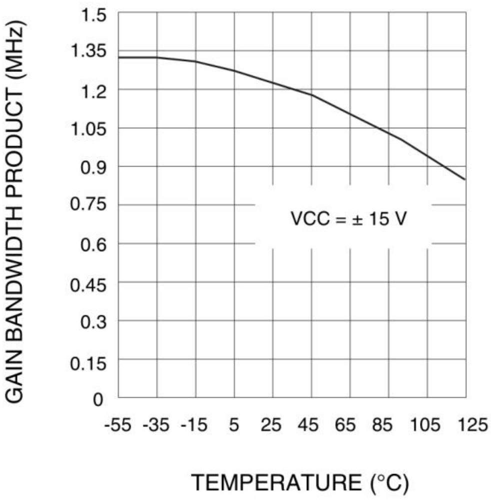


Figure 14. Gain bandwidth product

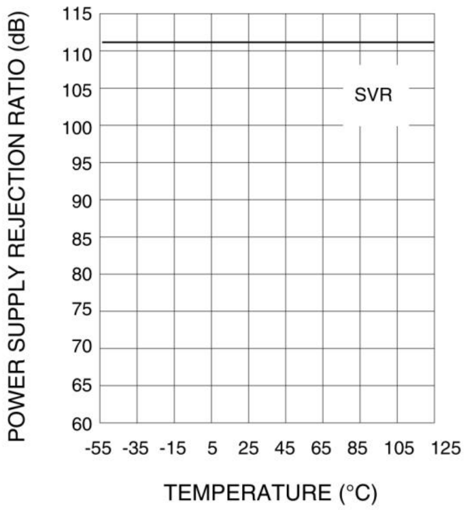


Figure 15. Power supply rejection ratio

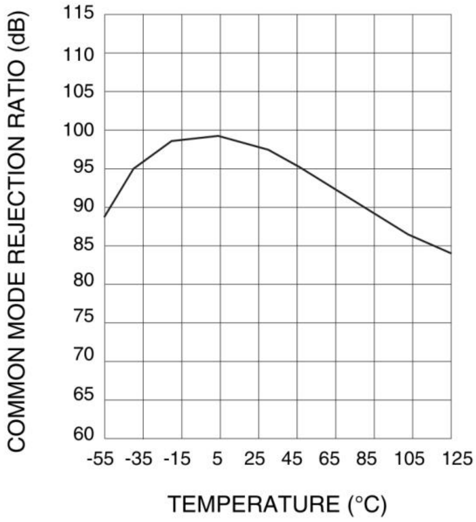


Figure 16. Common-mode rejection ratio

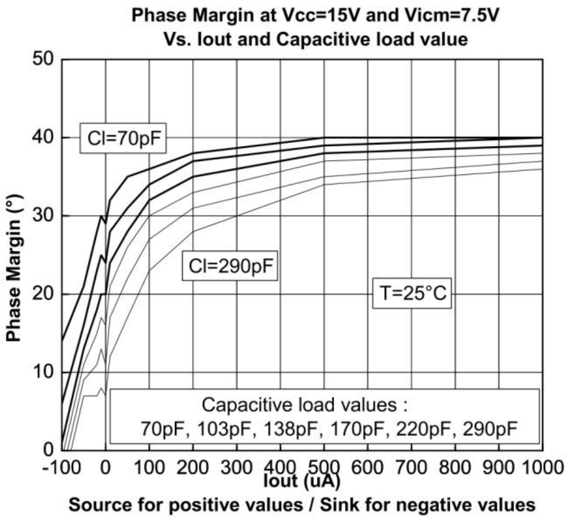


Figure 17. Phase margin vs. capacitive load

9. TYPICAL APPLICATIONS

Single supply voltage V_{CC} = +5 V_{DC}.

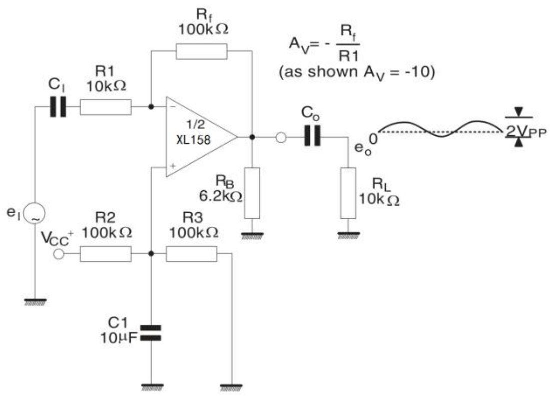


Figure 18. AC-coupled inverting amplifier

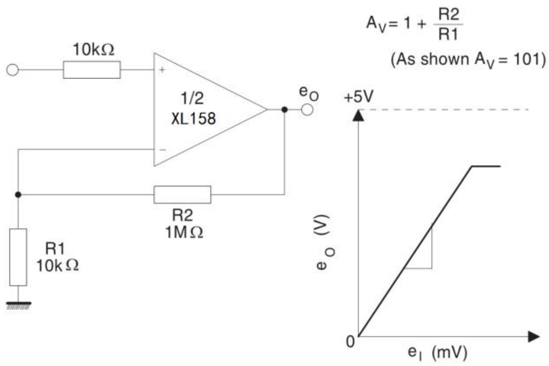


Figure 19. Non-inverting DC amplifier

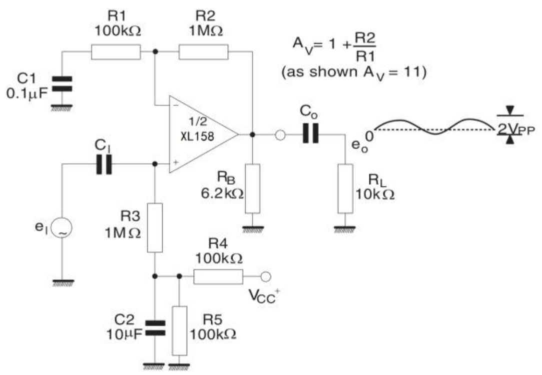


Figure 20. AC-coupled non-inverting amplifier

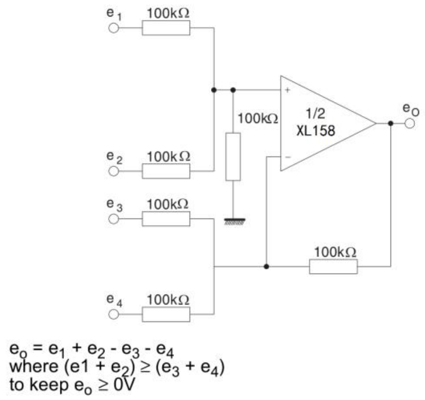


Figure 21. DC summing amplifier

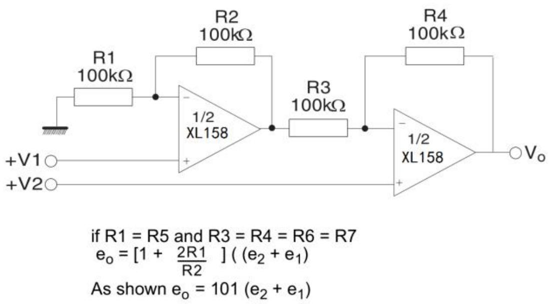


Figure 22. High input Z, DC differential amplifier

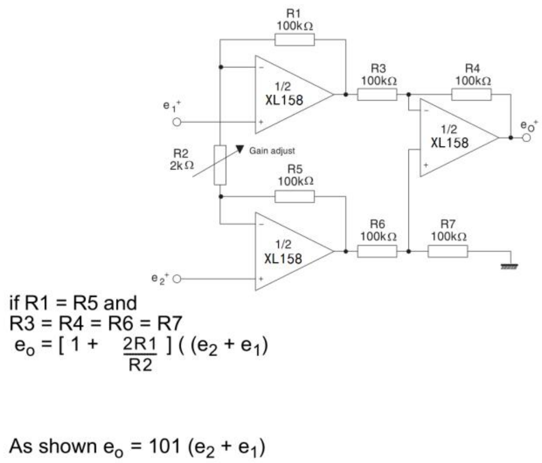


Figure 23. High input Z adjustable gain DC Instrumentation amplifier

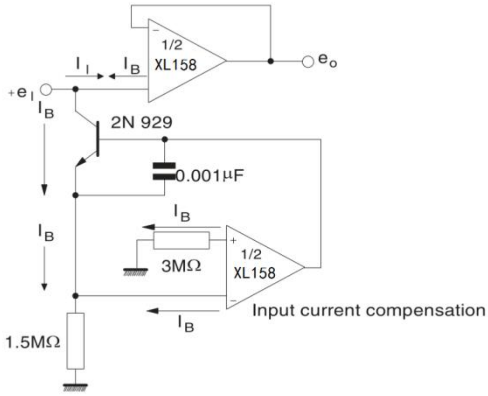


Figure 24. Using symmetrical amplifiers to reduce input current

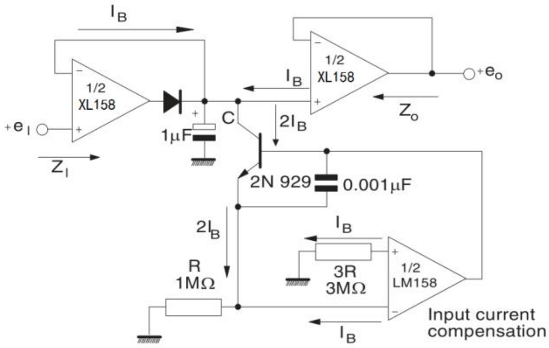


Figure 25. Low drift peak detector

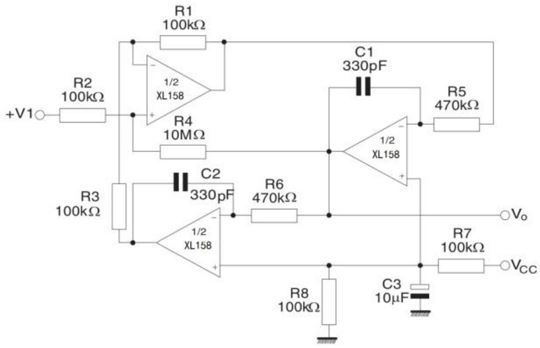


Figure 26. Active band-pass filter

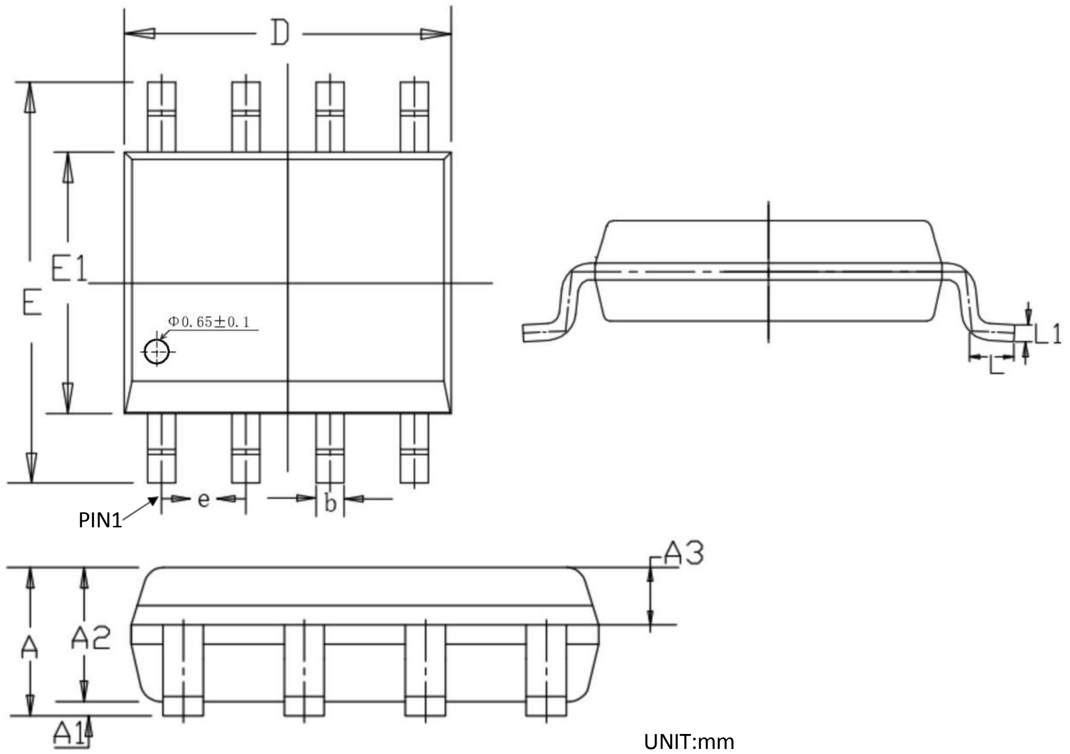
10. ORDERING INFORMATION

Ordering Information

Part Number	Device Marking	Package Type	Body size (mm)	Temperature (°C)	MSL	Transport Media	Package Quantity
XL158	XL158	SOP8	4.90 ∗ 3.90	- 40 to 105	MSL3	T&R	2500

11. DIMENSIONAL DRAWINGS

SOP8



UNIT:mm

	MIN	NOM	MAX
A	1.450	1.550	1.650
A1	0.100	0.150	0.200
A2	1.300	1.400	1.500
A3	0.600	0.650	0.700
b	0.380	–	0.510
e	1.240	1.270	1.300
D	4.800	4.900	5.000
E	5.800	6.000	6.200
E1	3.800	3.900	4.000
L	0.450	0.600	0.750
L1	—	0.25BSC	—