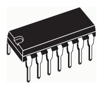
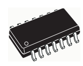
LM2902

Low Power Quad Operational Amplifier

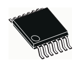
- Wide gain bandwidth: 1.3MHz
- Input common-mode voltage range includes ground
- Large voltage gain: 100dB
- Very low supply current per amp: 375µA
- Low input bias current: 20nA
- Low input offset current: 2nA
- Wide power supply range:
  - Single supply: +3V to +30V
  - Dual supplies: ±1.5V to ±15V



N
DIP14
(Plastic Package)



D
SO-14
(Plastic Micropackage)



P
TSSOP14
(Thin Shrink Small Outline Package)

Description

This circuit consists of four independent, high gain, internally frequency compensated operational amplifiers designed especially for automotive and industrial control systems.

It operates 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.

Order Codes

Part Number	Temperature Range	Package	Packing	Marking
LM2902N		DIP14	Tube	LM2902N
LM2902D/DT		SO-14	Tube or Tape & Reel	2902
LM2902PT	-40°C, +125°C	TSSOP14 (Thin Shrink Outline Package)	Tape & Reel	
LM2902YD/YDT		SO-14 (automotive grade level)	Tube or Tape & Reel	2902Y
LM2902YPT		TSSOP14 (automotive grade level)	Tape & Reel	

1 Absolute Maximum Ratings

Table 1. Key parameters and their absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	±16 to 33	V
V_{ID}	Differential Input Voltage	+32	V
V_I	Input Voltage	-0.3 to +32	V
	Output Short-circuit to Ground (1)	Infinite	
P_d	Power Dissipation (2) DIP14 SO-14	 500 400	mW
I_{in}	Input Current (3)	50	mA
T_{oper}	Operating Free-Air Temperature Range	-40 to +125	°C
T_{stg}	Storage Temperature Range	-65 to +150	°C
R_{thja}	Thermal Resistance Junction to Ambient SO-14 TSSOP14 DIP14	 100 103 66	°C/W
ESD	HBM: Human Body Model(4)	0.5	kV
	MM: Machine Model(5)	150	V
	CDM: Charged Device Model	1500	V

1. Short-circuit from the output to V_{cc}^+ can cause excessive heating and eventual destruction. The maximum output current is approximately 20mA, independent of the magnitude of V_{cc}^+
2. Pd is calculated with T_{amb} = +25°C, T_j = +150°C and
   R_{thja} = 80°C/W for DIP14 package
   R_{thja} = 150°C/W for SO-14 package
   R_{thja} = 175°C/W for TSSOP14 package
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. Human body model, 100pF discharged through a 1.5kΩ resistor into pin of device.
5. Machine model ESD, a 200pF cap is charged to the specified voltage, then discharged directly into the IC with no external series resistor (internal resistor < 5Ω), into pin to pin of device.

2 Typical Application Information

Figure 1. Schematic diagram (1/4 LM2902)

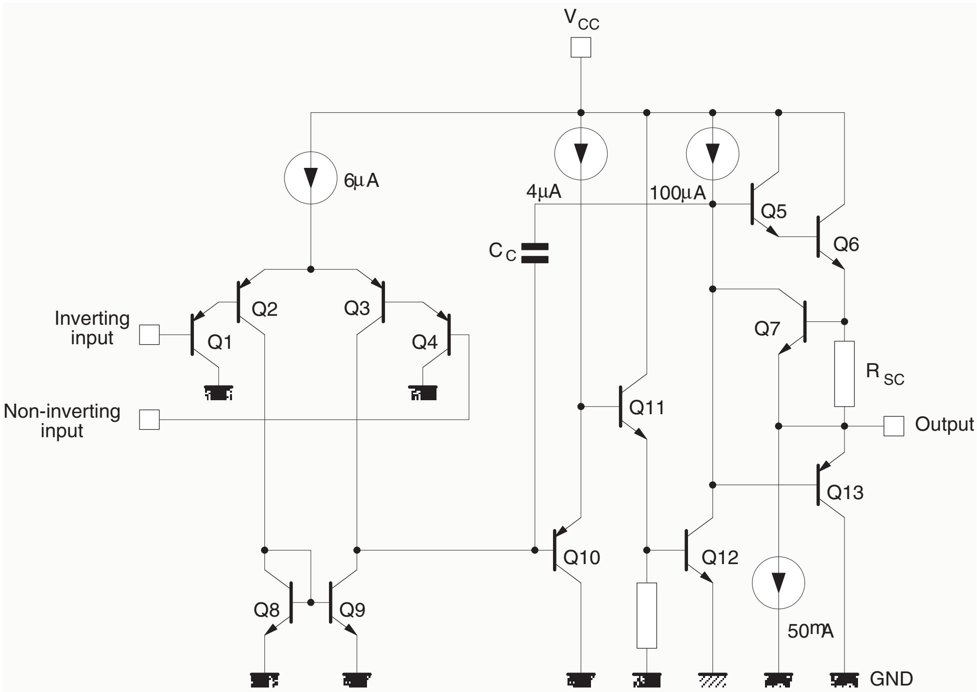
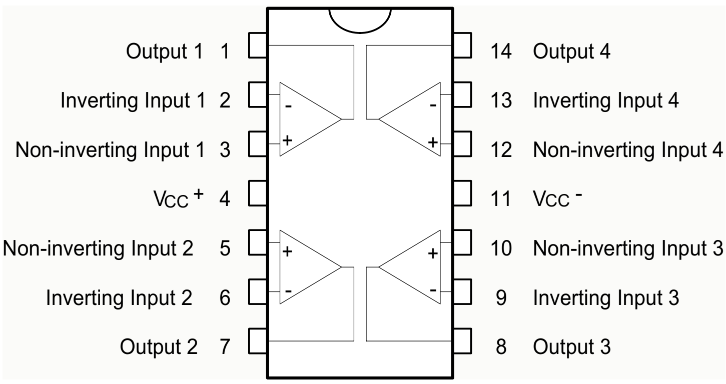


Figure 2. Pin connections (top view)



3 Electrical Characteristics

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage (1) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max.}$		2	7 9	mV
I_{io}	Input Offset Current $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max.}$		2	30 40	nA
I_{ib}	Input Bias Current (2) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max.}$		20	150 300	nA
A_{vd}	Large Signal Voltage Gain $V_{CC}^+ = +15V$, R_L=2kΩ, V_o = 1.4V to 11.4V $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max.}$	50 25	100		V/mV
SVR	Supply Voltage Rejection Ratio ($R_S \leq 10kΩ$) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max.}$	65 65	110		dB
I_{cc}	Supply Current, all Amp, no load $T_{amb} = +25°C$, $V_{CC} = +5V$ $V_{CC} = +30V$ $T_{min} \leq T_{amb} \leq T_{max.}$, $V_{CC} = +5V$ $V_{CC} = +30V$		0.7 1.5 0.8 1.5	1.2 3 1.2 3	mA
V_{icm}	Input Common Mode Voltage Range (V_{cc}= +30V)(3) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max.}$	0 0		V_{CC} -1.5 V_{CC} -2	V
CMR	Common-mode Rejection Ratio ($R_S \leq 10kΩ$) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max.}$	70 60	80		dB
I_O	Output Short-circuit Current (V_{id} = +1V) $V_{CC} = +15V$, $V_o = +2V$	20	40	70	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		mA µA
V_{OH}	High Level Output Voltage (V_{cc} + 30V) $T_{amb} = +25°C$, R_L = 2kΩ $T_{min} \leq T_{amb} \leq T_{max.}$ $T_{amb} = +25°C$, R_L = 10kΩ $T_{min} \leq T_{amb} \leq T_{max.}$ V_{cc} + 5V), R_L = 2kΩ $T_{min} \leq T_{amb} \leq T_{max.}$ $T_{amb} = +25°C$	26 26 27 27 3.5 3	27 28		V

Symbol	Parameter	Min.	Typ.	Max.	Unit
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	mV
SR	Slew Rate $V_{CC} = 15V$, Vi = 0.5 to 3V, $R_L = 2k\Omega$, $C_L = 100pF$, unity gain		0.4		V/µs
GBP	Gain Bandwidth Product $V_{CC} = 30V$, $V_{in} = 10mV$, $R_L = 2k\Omega$, $C_L = 100pF$		1.3		MHz
THD	Total Harmonic Distortion f = 1kHz, $A_V = 20dB$, $R_L = 2k\Omega$, $V_o = 2Vpp$, $C_L = 100pF$, $V_{cc} = 30V$		0.015		%
e_n	Equivalent Input Noise Voltage f = 1kHz, $R_S = 100\Omega$, $V_{cc} = 30V$		40		$\frac{nV}{\sqrt{Hz}}$
DV_{io}	Input Offset Voltage Drift		7	30	µV/°C
DI_{io}	Input Offset Current Drift		10	200	pA/°C
V_{O1}/V_{O2}	Channel Separation (4) $1kHz \le f \le 20kHz$		120		dB

1. $V_O = 1.4V$, $R_S = 0\Omega$, $5V < V_{CC}^+ < 30V$, $0V < V_{ic} < V_{CC}^+ - 1.5V$.
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 charge 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 frequencies.

Figure 3. Input bias current vs. T_{amb}

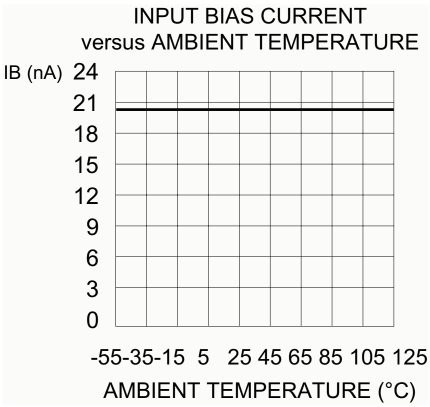


Figure 4. Input voltage range

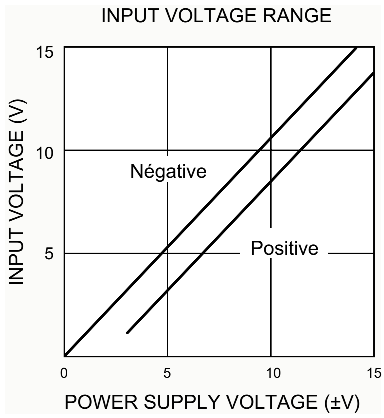


Figure 5. Current limiting

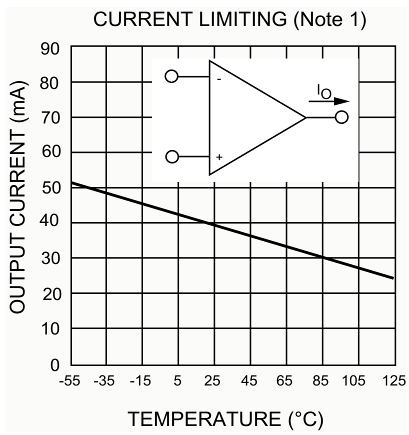


Figure 6. Supply current

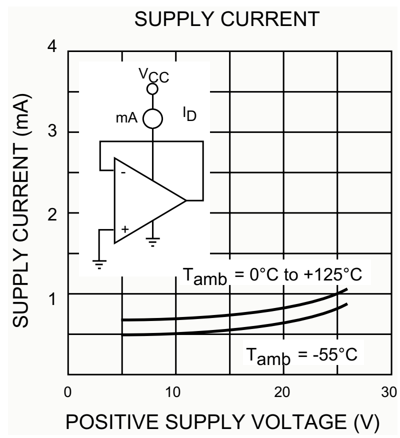


Figure 7. Gain bandwidth product

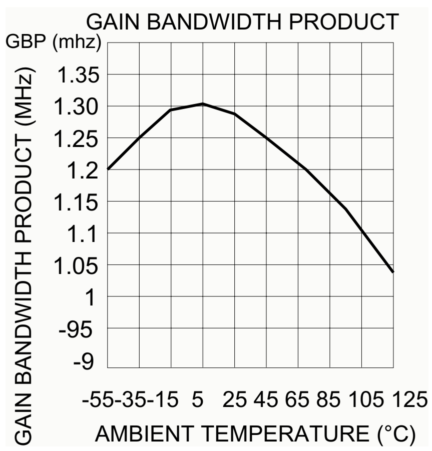


Figure 8. Voltage follower pulse response

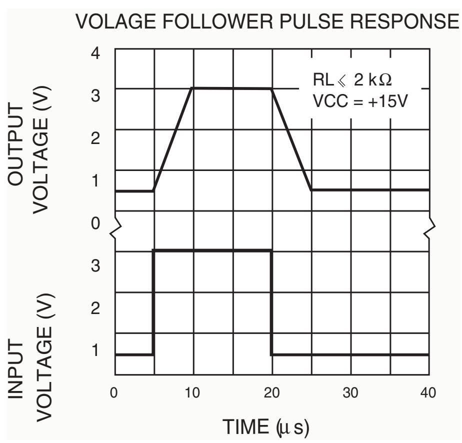


Figure 9. Common mode rejection ratio

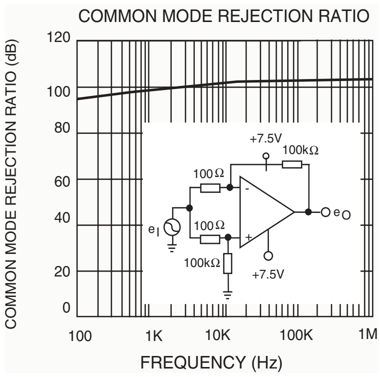


Figure 10. Output characteristics

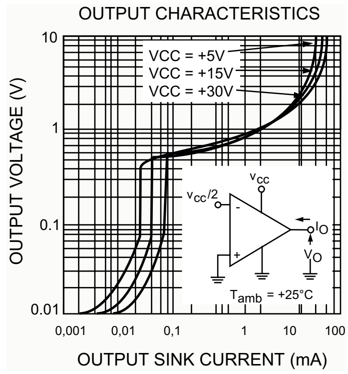


Figure 11. Open loop frequency response

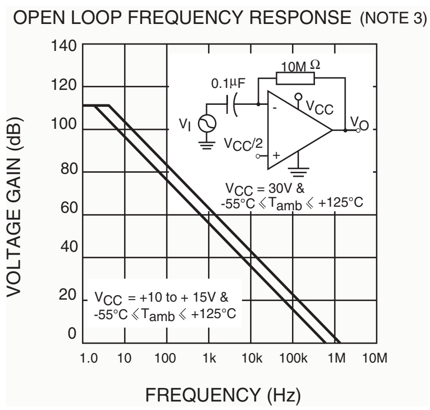


Figure 12. Voltage follower pulse response

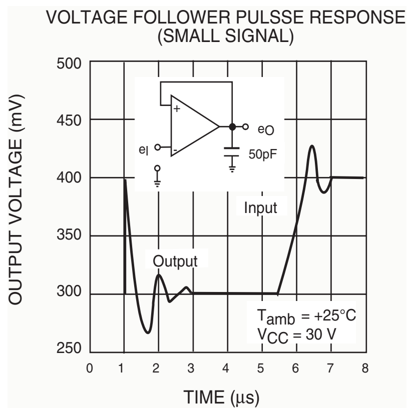


Figure 13. Large signal frequency response

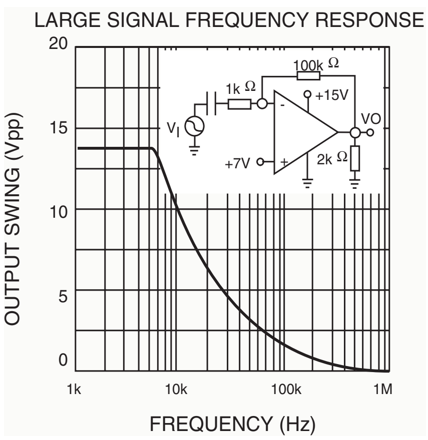


Figure 14. Output characteristics

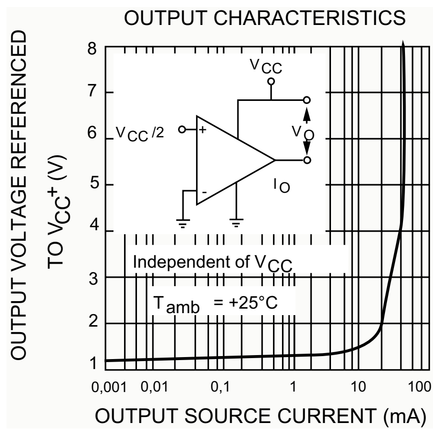


Figure 15. Positive supply voltage

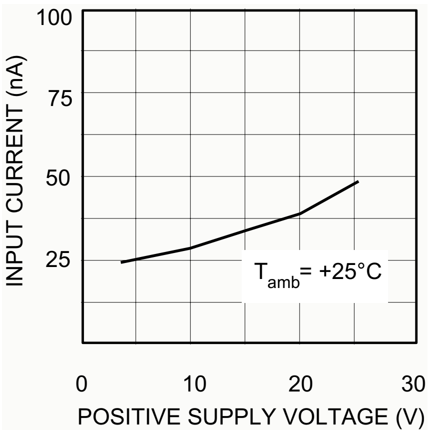


Figure 16. Positive supply voltage

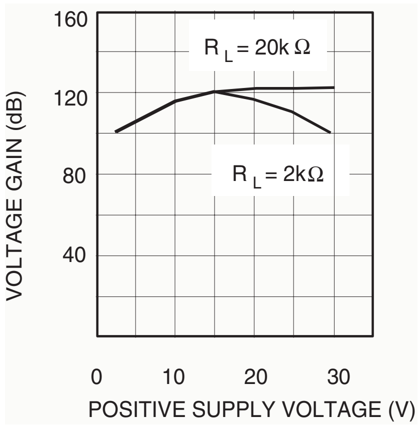


Figure 17. Power supply & common mode rejection ratio

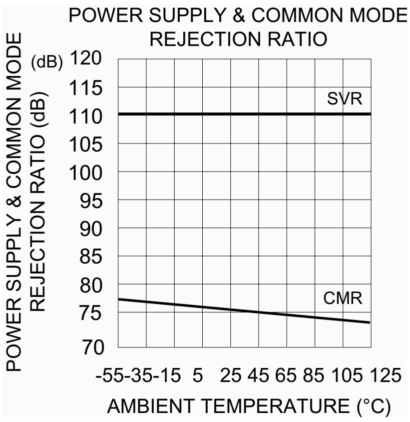
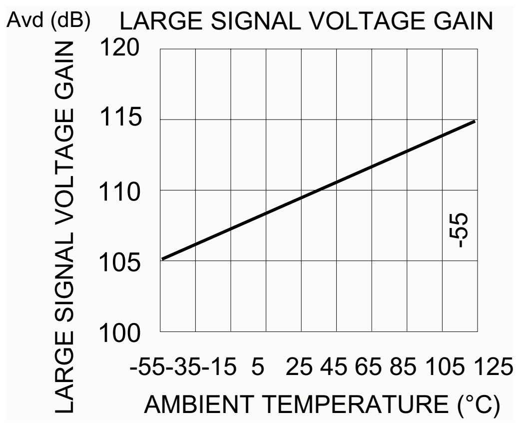


Figure 18. Large signal voltage gain



4 Typical Single-Supply Applications

Figure 19. AC coupled inverting amplifier

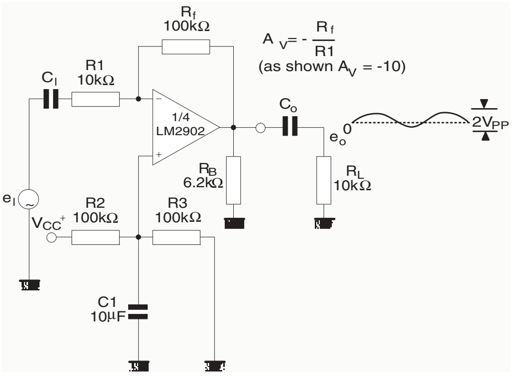


Figure 20. AC coupled non-inverting amplifier

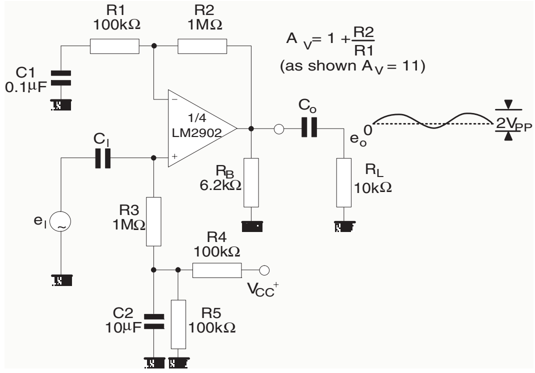


Figure 21. Non-inverting DC gain

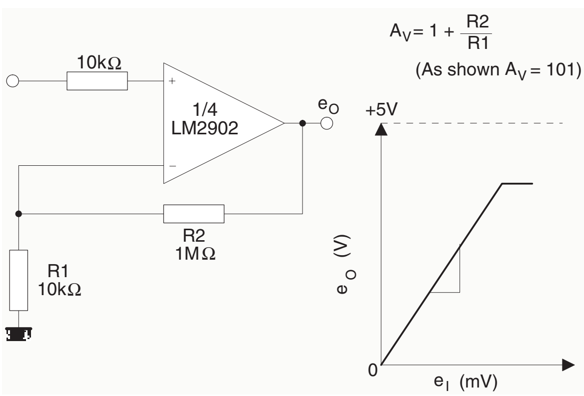


Figure 22. DC summing amplifier

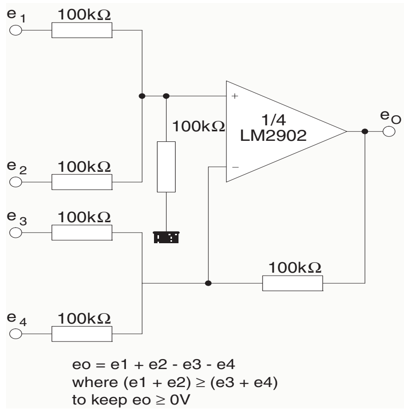


Figure 23. Active bandpass filter

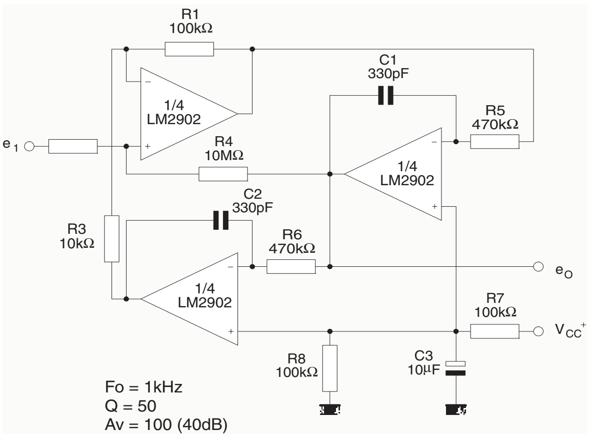


Figure 24. High input Z adjustable gain DC instrumentation amplifier

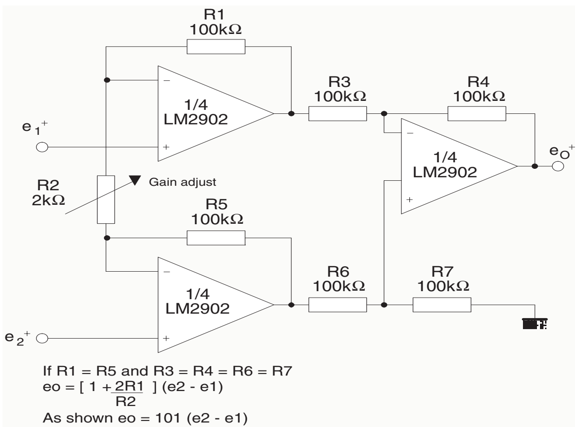


Figure 25. High input Z, DC differential amplifier

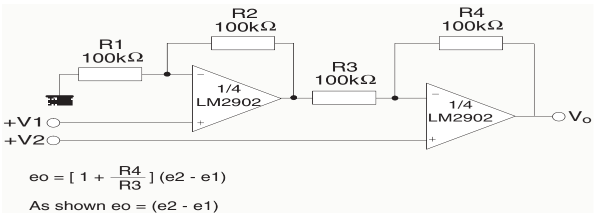
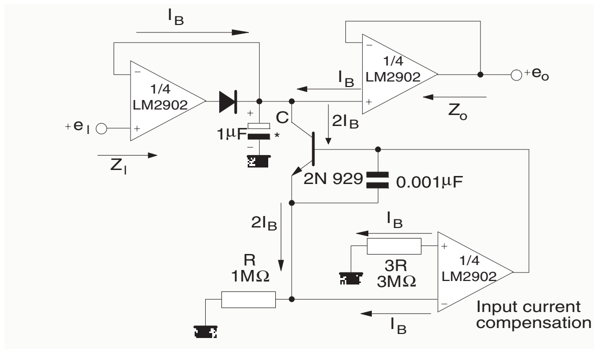
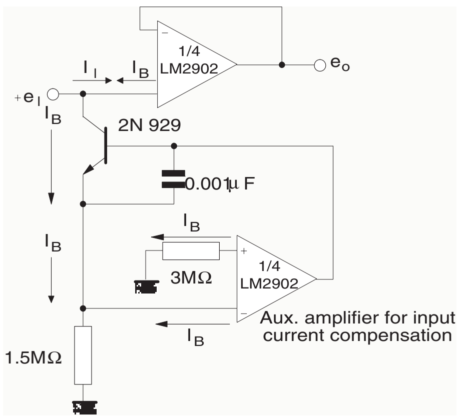


Figure 26. Low drift peak detector



* Polycarbonate or polyethylene

Figure 27. Using symmetrical amplifiers to reduce input current (general concept)



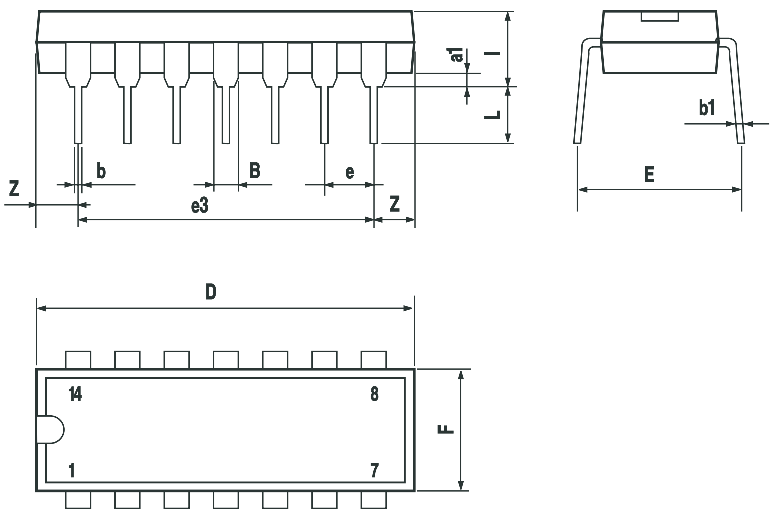
5 Package Mechanical Data

In order to meet environmental requirements, ST 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 ST trademark. ECOPACK specifications are available at: www.st.com.

5.1 DIP14 package

Plastic DIP-14 MECHANICAL DATA

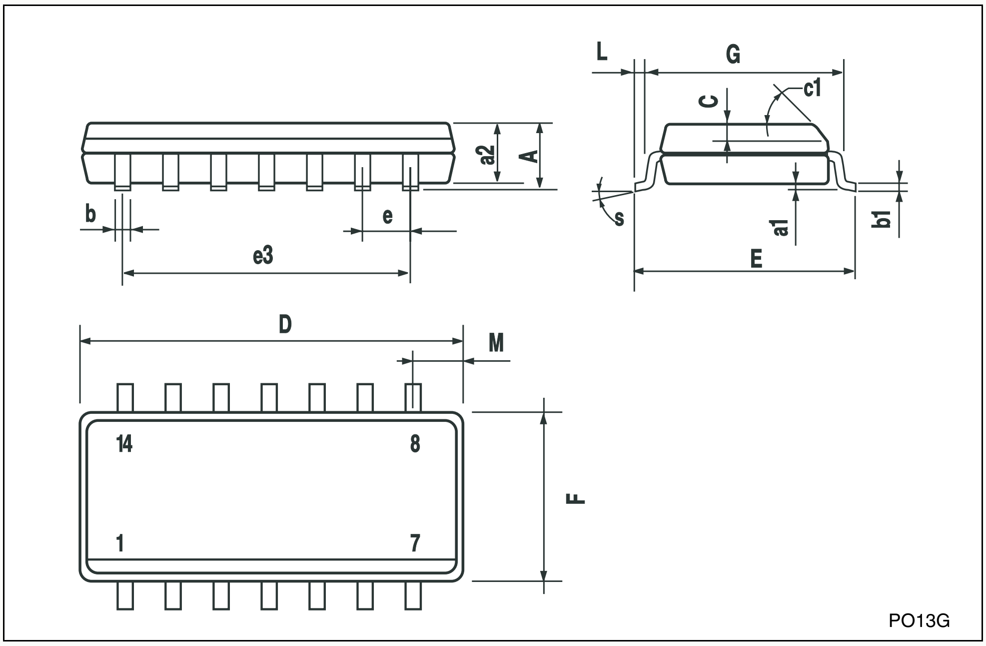
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100



P001A

5.2 SO-14 package

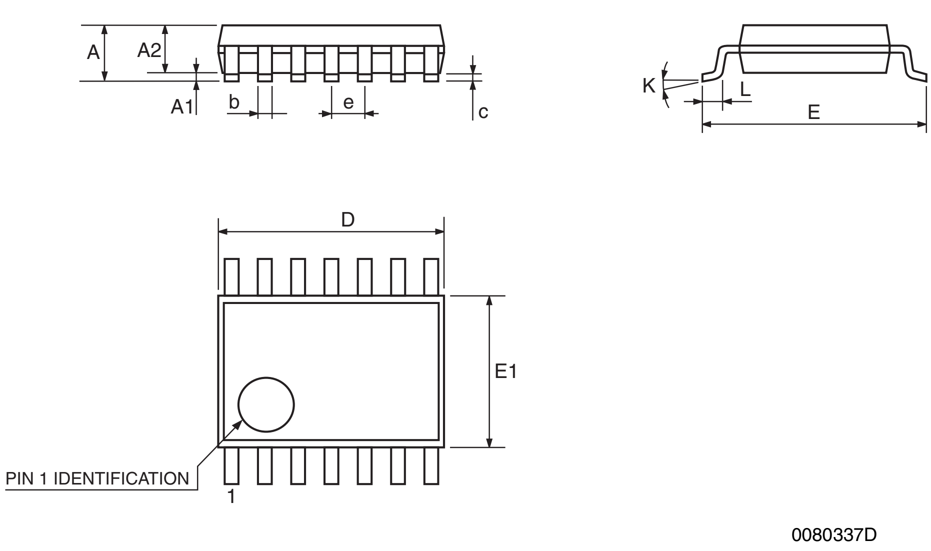
SO-14 MECHANICAL DATA						
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.003		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45˚ (typ.)					
D	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.68			0.026
S	8˚ (max.)					



5.3 TSSOP14 package

TSSOP14 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.2			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.8	1	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0089
D	4.9	5	5.1	0.193	0.197	0.201
E	6.2	6.4	6.6	0.244	0.252	0.260
E1	4.3	4.4	4.48	0.169	0.173	0.176
e		0.65 BSC			0.0256 BSC	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030



6 Revision History

Date	Revision	Changes
Nov. 2001	1	Initial release.
July 2005	2	1 - PPAP references inserted in the datasheet see *Table : Order Codes on page 1*. 2 - ESD protection inserted in *Table 1 on page 2*.
Oct. 2005	3	The following changes were made in this revision: – An error in the device description was corrected on page 1. – PPAP reference inserted in the datasheet see *Table : Order Codes on page 1*. – Minor grammatical and formatting changes throughout.