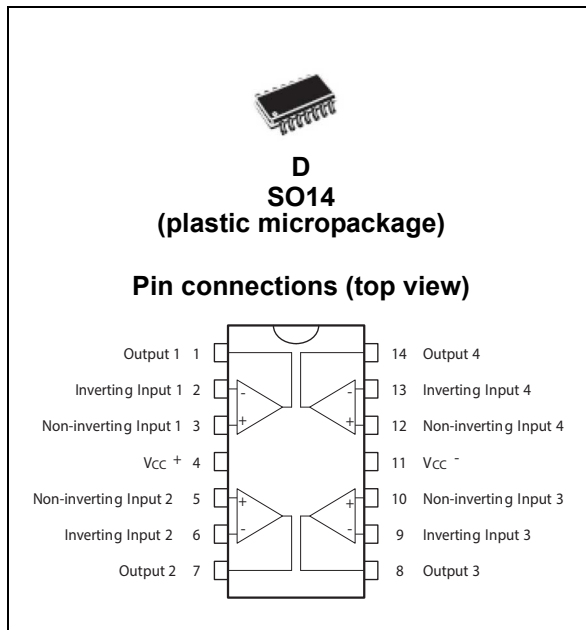


## RobuST low-power quad operational amplifier

Datasheet - production data



- Extended product change notification process
- Designed and manufactured to meet sub ppm quality goals
- Advanced mold and frame designs for superior resilience to harsh environments (acceleration, EMI, thermal, humidity)
- Extended screening capability on request
- Single fabrication, assembly, and test site
- Temperature range (-40 °C to 125 °C)

### Applications

- Aerospace and defense
- Harsh environments

### Description

This circuit consists of four independent, high gain operational amplifiers which employ internal frequency compensation and are specifically designed for aerospace and defense systems.

The device 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 from the power supply voltage magnitude.

### Features

- Wide gain bandwidth: 1.3 MHz
- Input common-mode voltage range includes negative rail
- Large voltage gain: 100 dB
- Very low supply current per amplifier: 375  $\mu$ A
- Low input bias current: 20 nA
- Low input offset current: 2 nA
- Wide power supply range:
  - Single supply: 3 V to 30 V
  - Dual supplies:  $\pm 1.5$  V to  $\pm 15$  V
- Intended for use in aerospace and defense applications:
  - Dedicated traceability and part marking
  - Approval documents available for production parts
  - Adapted extended life time and obsolescence management

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# 1 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings (AMR)**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply voltage <sup>(1)</sup>	±16 to 33	V
$V_{id}$	Differential input voltage <sup>(2)</sup>	32	
$V_{in}$	Input voltage	-0.3 to 32	
	Output short-circuit duration <sup>(3)</sup>	Infinite	s
$T_j$	Maximum junction temperature	150	°C
$I_{in}$	Input current <sup>(4)</sup> : $V_{in}$ driven negative	5 in DC or 50 in AC (duty cycle = 10 %, $T = 1$ s)	mA
	Input current <sup>(5)</sup> : $V_{in}$ driven positive above AMR value	0.4	
$T_{stg}$	Storage temperature range	-65 to 150	°C
$R_{thja}$	Thermal resistance junction to ambient <sup>(6)</sup>	105	°C/W
$R_{thjc}$	Thermal resistance junction to case <sup>(6)</sup>	31	
ESD	HBM: human body model <sup>(7)</sup>	370	V
	MM: machine model <sup>(8)</sup>	150	
	CDM: charged device model <sup>(9)</sup>	1500	

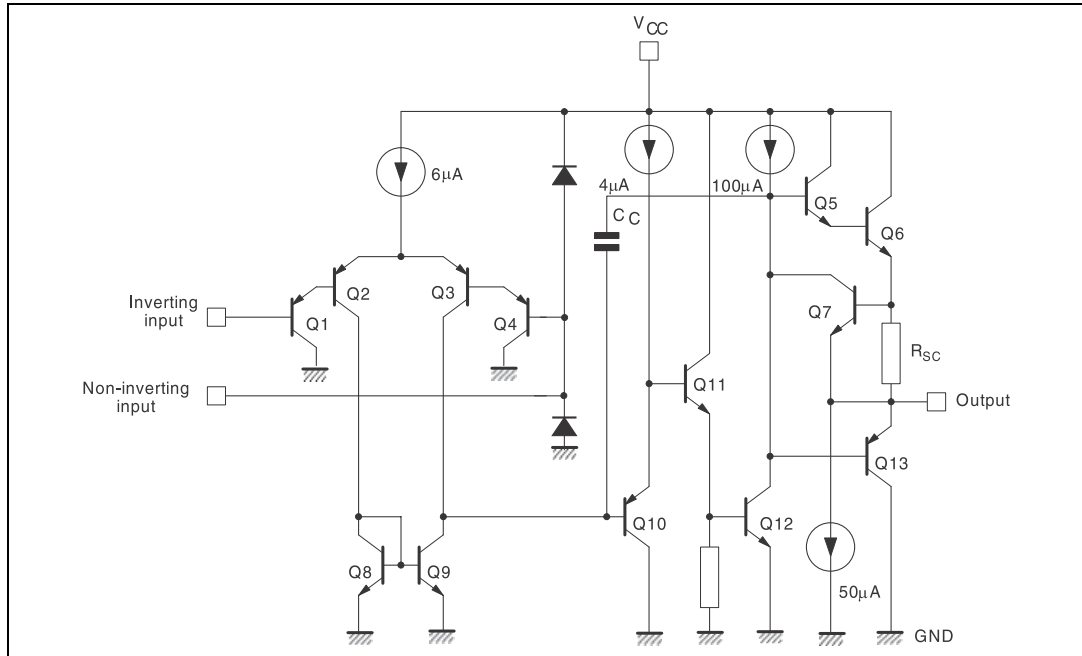
- All voltage values, except the differential voltage are with respect to network ground terminal.
- Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
- Short-circuit from the output to  $V_{CC}^+$  can cause excessive heating and eventual destruction. The maximum output current is approximately 20 mA, independent of the magnitude of  $V_{CC}^+$ .
- 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 an input diode clamp. In addition to this diode action, there is an NPN parasitic action on the IC chip. This transistor action can cause the output voltages of the op amp 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.
- The junction base/substrate of the input PNP transistor polarized in reverse must be protected by a resistor in series with the inputs to limit the input current to 400  $\mu$ A max ( $R = (V_{in} - 36 \text{ V})/400 \mu\text{A}$ ).
- $R_{thja/c}$  are typical values
- Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 k $\Omega$  resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
- 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  $\Omega$ ). This is done for all couples of connected pin combinations while the other pins are floating.
- 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.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply voltage	3 to 30	V
$V_{icm}$	Common mode input voltage range	$(V_{CC}^+) - 1.5$	
	$T_{min} \leq T_{amb} \leq T_{max}$	$(V_{CC}^+) - 2$	
$T_{oper}$	Operating free-air temperature range	-40 to 125	°C

## 2 Schematic diagram

Figure 1. Schematic diagram (1/4 RT2902)



### 3 Electrical characteristics

**Table 3.  $V_{CC}^+ = 5\text{ V}$ ,  $V_{CC}^- = \text{ground}$ ,  $V_o = 1.4\text{ V}$ ,  $T_{\text{amb}} = 25\text{ }^\circ\text{C}$   
(unless otherwise specified)**

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input offset voltage <sup>(1)</sup>		2	7	mV
	Input offset voltage <sup>(1)</sup> , $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$			9	
$\Delta V_{io}/\Delta T$	Input offset voltage drift		7	30	$\mu\text{V}/^\circ\text{C}$
$I_{io}$	Input offset current		2	30	nA
	Input offset current, $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$			40	
$DI_{io}$	Input offset current drift		10	200	$\text{pA}/^\circ\text{C}$
$I_{ib}$	Input bias current <sup>(2)</sup>		20	150	nA
	Input bias current <sup>(2)</sup> , $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$			300	
$A_{vd}$	Large signal voltage gain ( $V_{CC}^+ = 15\text{ V}$ , $R_L = 2\text{ k}\Omega$ , $V_o = 1.4\text{ V to } 11.4\text{ V}$ )	50	100		V/mV
	Large signal voltage gain ( $V_{CC}^+ = 15\text{ V}$ , $R_L = 2\text{ k}\Omega$ , $V_o = 1.4\text{ V to } 11.4\text{ V}$ ), $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	25			
SVR	Supply voltage rejection ratio ( $R_S \leq 10\text{ k}\Omega$ )	65	110		dB
	Supply voltage rejection ratio ( $R_S \leq 10\text{ k}\Omega$ ), $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	65			
$I_{cc}$	Supply current, all amps, no load $V_{CC}^+ = 5\text{ V}$ $V_{CC}^+ = 30\text{ V}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ $V_{CC}^+ = 5\text{ V}$ $V_{CC}^+ = 30\text{ V}$		0.7	1.2	mA
			1.5	3	
			0.8	1.2	
			1.5	3	
CMR	Common-mode rejection ratio ( $R_S \leq 10\text{ k}\Omega$ )	70	80		dB
	Common-mode rejection ratio ( $R_S \leq 10\text{ k}\Omega$ ), $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	60			
$I_o$	Output short-circuit current ( $V_{id} = 1\text{ V}$ , $V_{CC}^+ = 15\text{ V}$ , $V_o = 2\text{ V}$ )	20	40	70	mA
$I_{\text{sink}}$	Output sink current ( $V_{id} = -1\text{ V}$ )				
	$V_{CC}^+ = 15\text{ V}$ , $V_o = 2\text{ V}$ $V_{CC}^+ = 15\text{ V}$ , $V_o = 0.2\text{ V}$	10 12	20 50		mA $\mu\text{A}$
$V_{OH}$	High level output voltage ( $V_{CC}^+ = 30\text{ V}$ ) $R_L = 2\text{ k}\Omega$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ $R_L = 10\text{ k}\Omega$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ $V_{CC}^+ = 5\text{ V}$ , $R_L = 2\text{ k}\Omega$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	26	27		V
		26			
		27	28		
		27			
		3			
3.5					

**Table 3.  $V_{CC}^+ = 5\text{ V}$ ,  $V_{CC}^- = \text{ground}$ ,  $V_o = 1.4\text{ V}$ ,  $T_{\text{amb}} = 25\text{ °C}$   
(unless otherwise specified) (continued)**

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{OL}$	Low level output voltage ( $R_L = 10\text{ k}\Omega$ )		5	20	mV
	Low level output voltage ( $R_L = 10\text{ k}\Omega$ ), $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$			20	
SR	Slew rate ( $V_{CC}^+ = 15\text{ V}$ , $V_{\text{in}} = 0.5\text{ to }3\text{ V}$ , $R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , unity gain)		0.4		V/ $\mu\text{s}$
GBP	Gain bandwidth product ( $V_{CC}^+ = 30\text{ V}$ , $V_{\text{in}} = 10\text{ mV}$ , $R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ )		1.3		MHz
THD	Total harmonic distortion ( $f = 1\text{ kHz}$ , $A_V = 20\text{ dB}$ , $R_L = 2\text{ k}\Omega$ , $V_o = 2\text{ V}_{\text{pp}}$ , $C_L = 100\text{ pF}$ , $V_{CC}^+ = 30\text{ V}$ )		0.015		%
$e_n$	Equivalent input noise voltage ( $f = 1\text{ kHz}$ , $R_S = 100\ \Omega$ , $V_{CC}^+ = 30\text{ V}$ )		40		$\frac{\text{nV}}{\sqrt{\text{Hz}}}$
$V_{O1}/V_{O2}$	Channel separation <sup>(3)</sup> ( $1\text{ kHz} \leq f \leq 20\text{ kHz}$ )		120		dB

- $V_o = 1.4\text{ V}$ ,  $R_S = 0\ \Omega$ ,  $5\text{ V} < V_{CC}^+ < 30\text{ V}$ ,  $0\text{ V} < V_{\text{ic}} < (V_{CC}^+) - 1.5\text{ V}$ .
- 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 loading charge on the input lines.
- Due to the proximity of external components ensure stray capacitance does not cause coupling between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies.

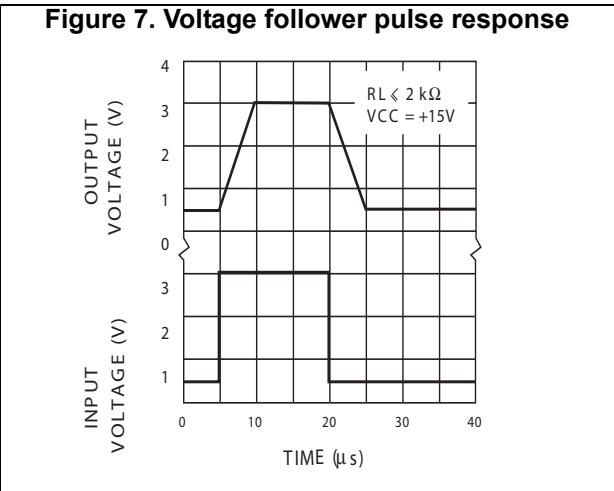
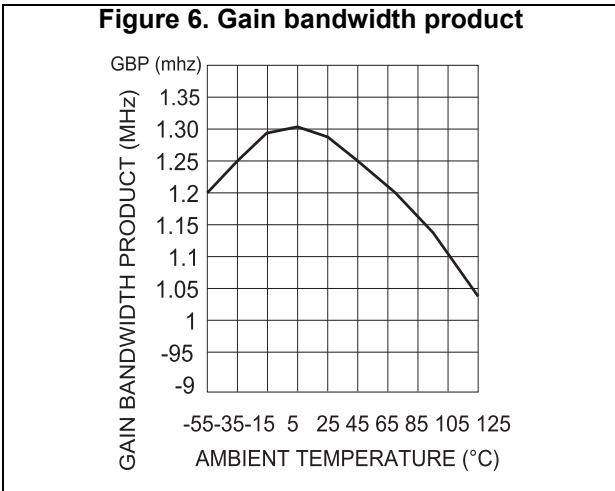
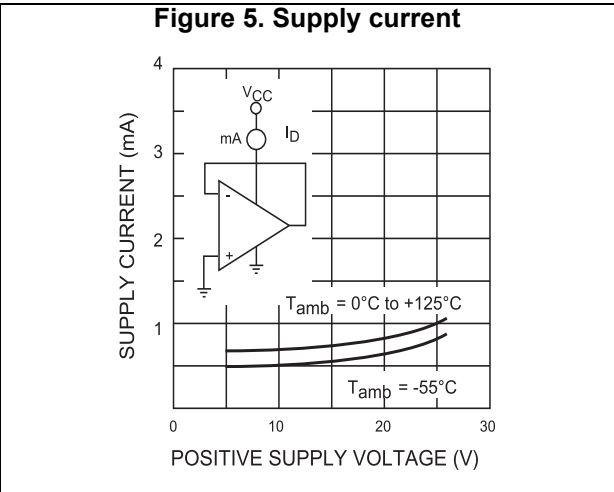
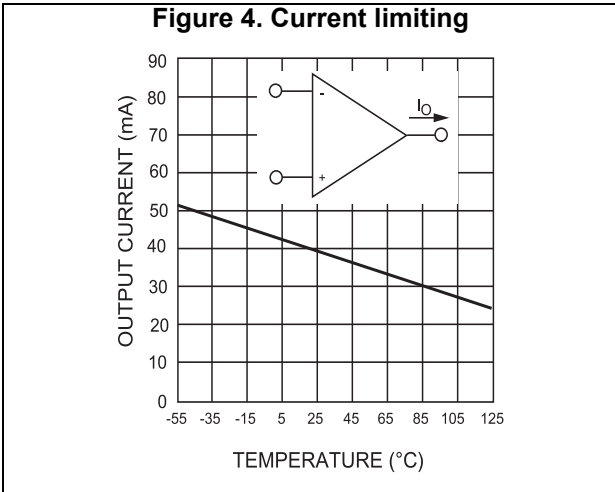
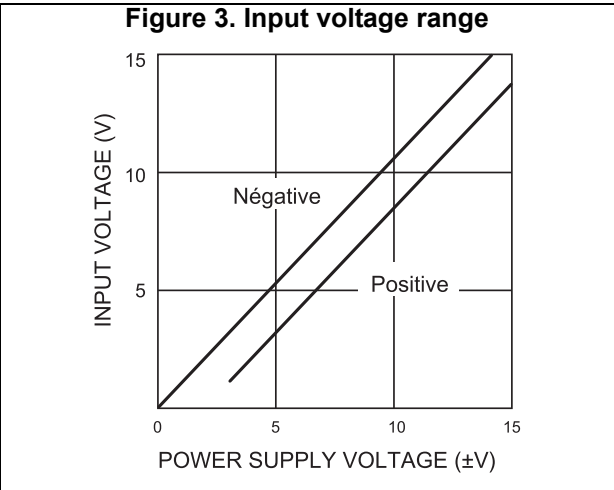
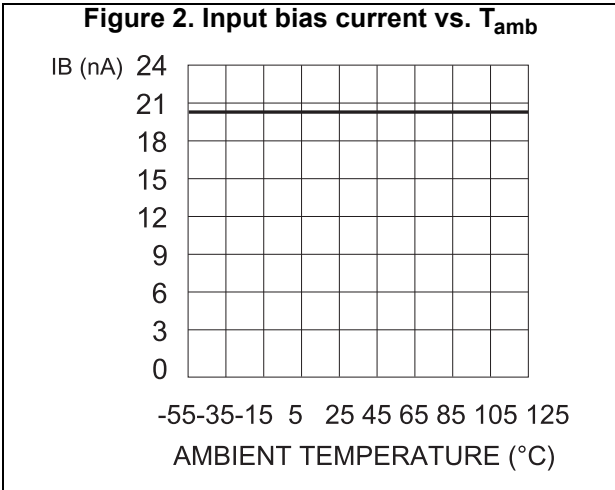




Figure 8. Common mode rejection ratio

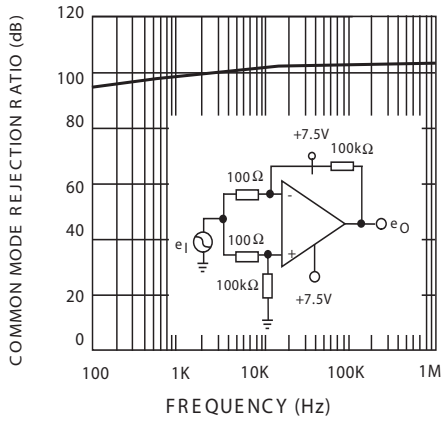


Figure 9. Output characteristics (sink)

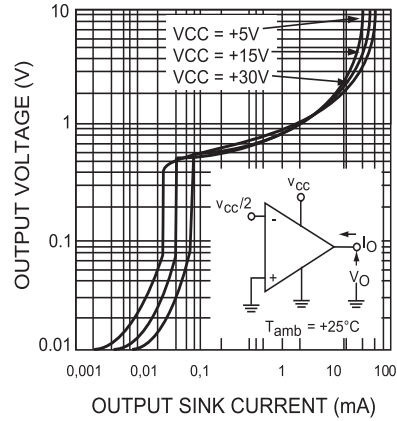


Figure 10. Open-loop frequency response

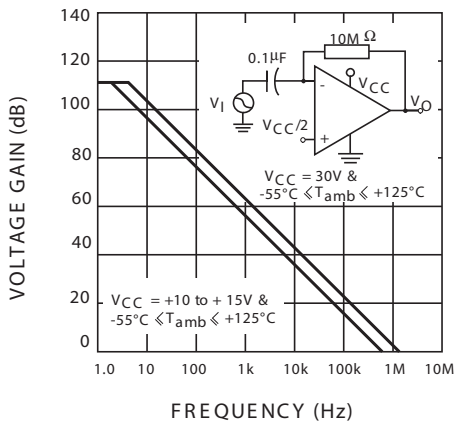


Figure 11. Voltage follower pulse response

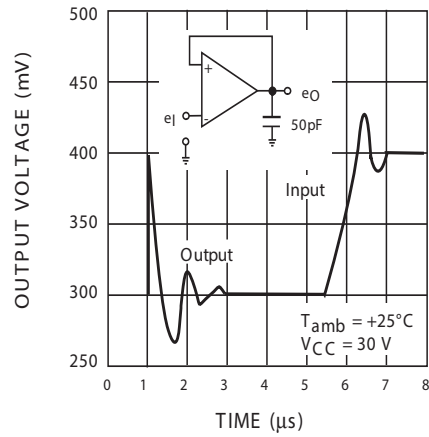


Figure 12. Large signal frequency response

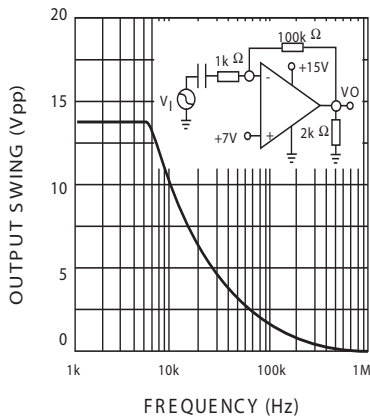
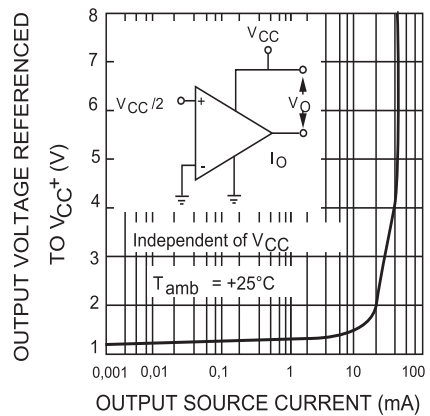
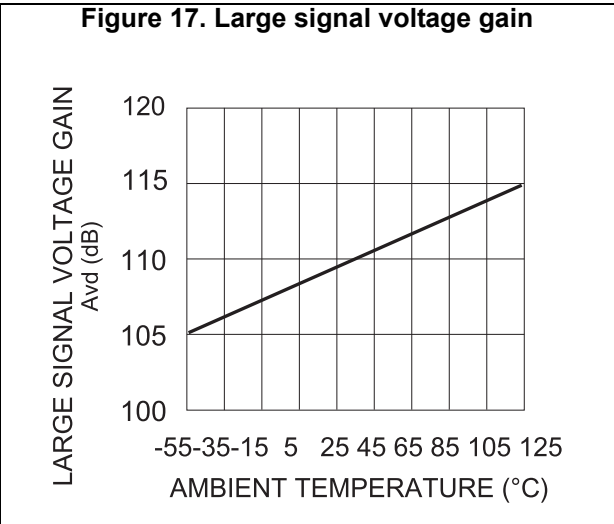
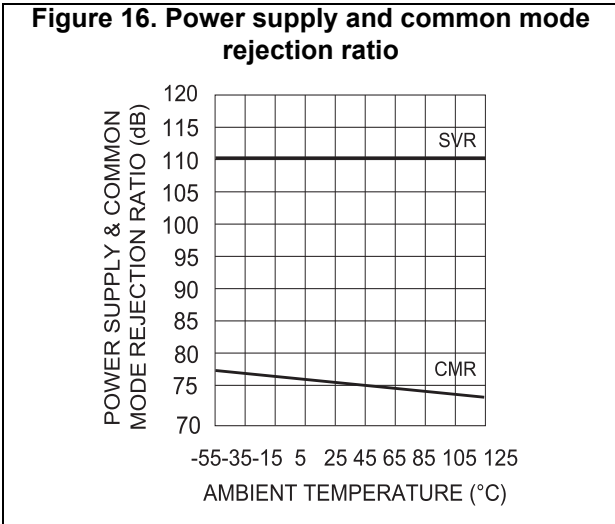
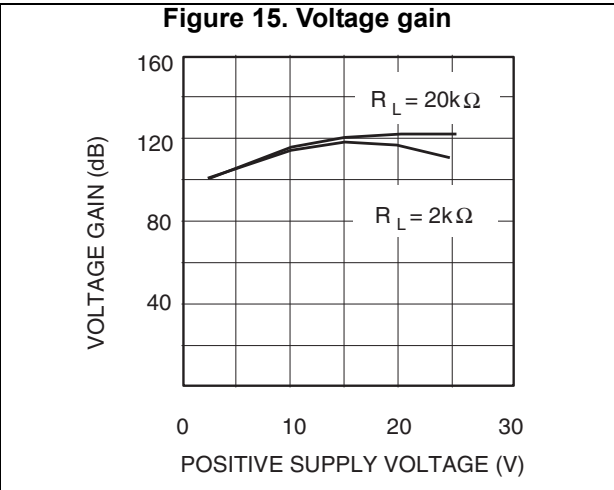
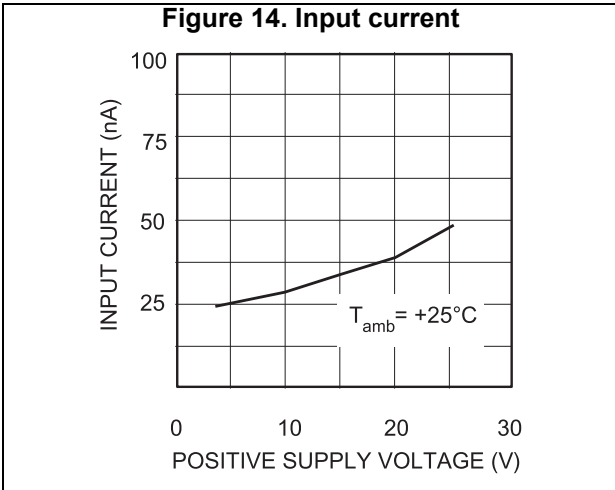


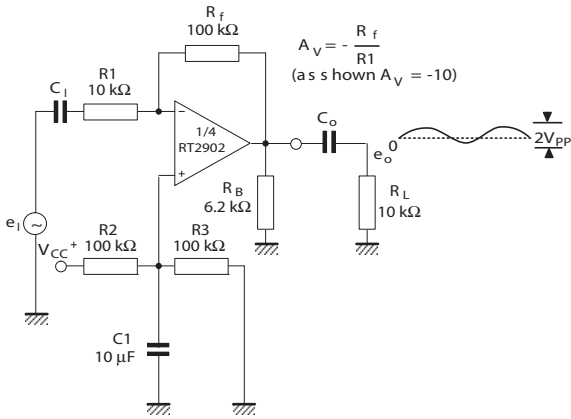
Figure 13. Output characteristics (source)



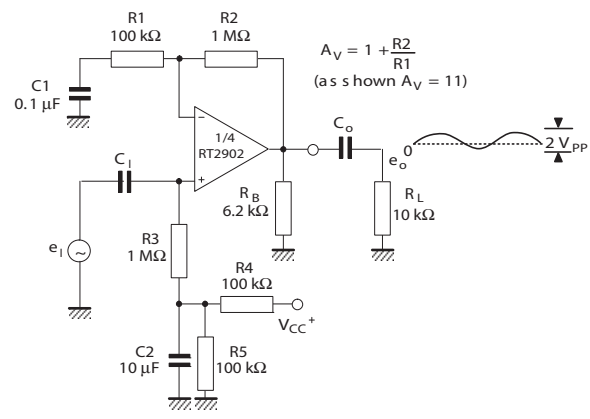


# 4 Typical single-supply applications

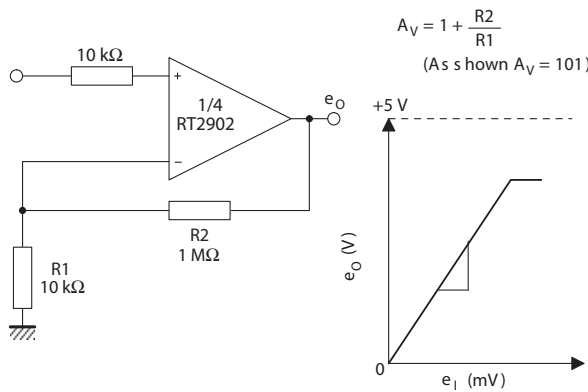
**Figure 18. AC coupled inverting amplifier**



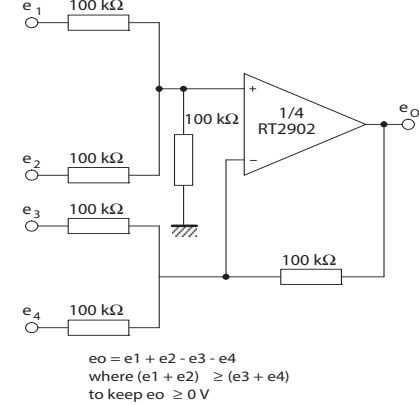
**Figure 19. AC coupled non-inverting amplifier**



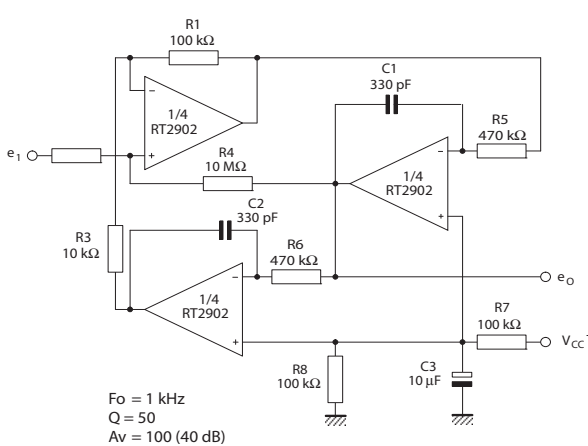
**Figure 20. Non-inverting DC gain**



**Figure 21. DC summing amplifier**



**Figure 22. Active bandpass filter**



**Figure 23. High input Z adjustable gain DC instrumentation amplifier**

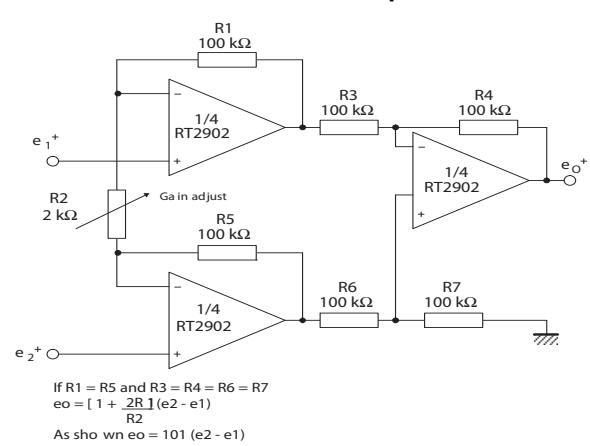


Figure 24. High input Z, DC differential amplifier

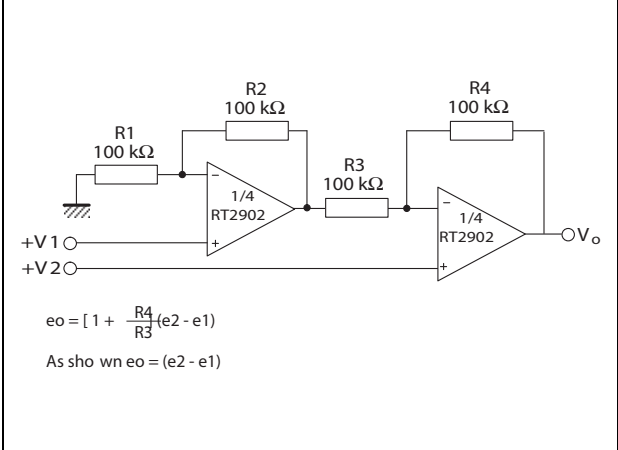


Figure 25. Low drift peak detector

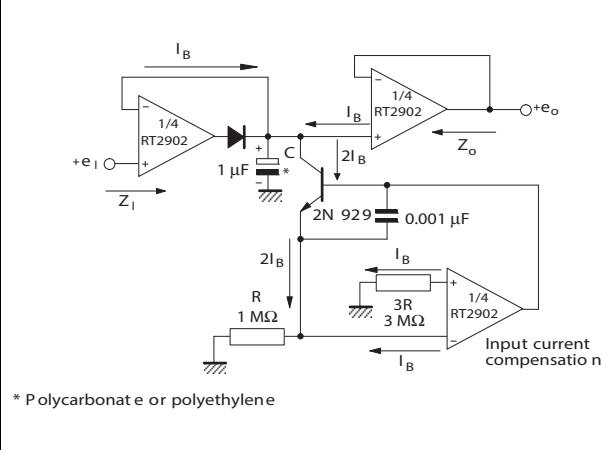
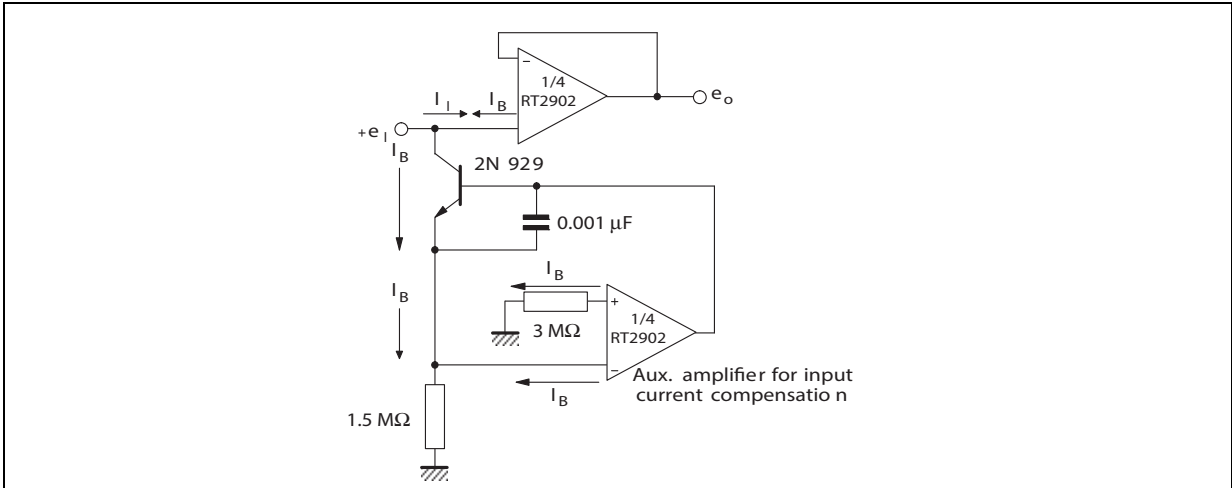


Figure 26. Using symmetrical amplifiers to reduce input current (general concept)



## 5 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

### 5.1 SO14 package information

Figure 27. SO14 package mechanical drawing

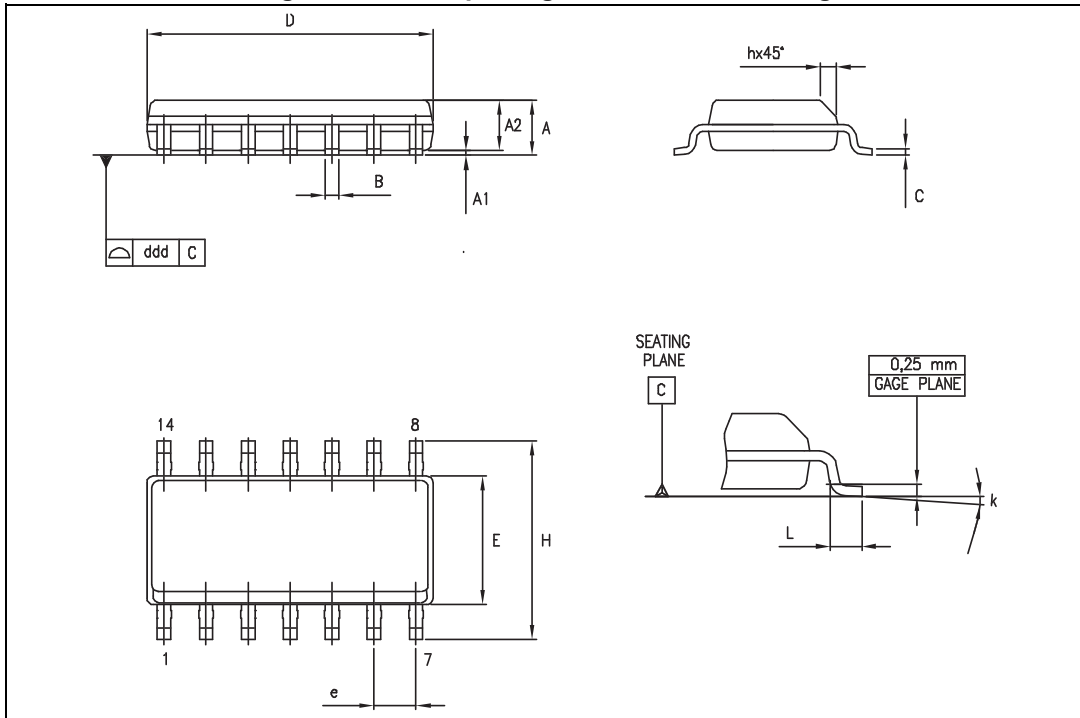


Table 4. SO14 package mechanical data

Dimensions						
Ref.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.35		1.75	0.05		0.068
A1	0.10		0.25	0.004		0.009
A2	1.10		1.65	0.04		0.06
B	0.33		0.51	0.01		0.02
C	0.19		0.25	0.007		0.009
D	8.55		8.75	0.33		0.34
E	3.80		4.0	0.15		0.15
e		1.27			0.05	
H	5.80		6.20	0.22		0.24
h	0.25		0.50	0.009		0.02
L	0.40		1.27	0.015		0.05
k	8° (max.)					
ddd			0.10			0.004

## 6 Ordering information

Table 5. Order codes

Order code	Temperature range	Package	Packing	Marking
RT2902YDT	-40 °C to 125 °C	SO14	Tape and reel	R2902Y

## 7 Revision history

Table 6. Document revision history

Date	Revision	Changes
08-Oct-2014	1	Initial release

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[LTC1040CN#PBF](#) [LT6700MPDCB-1#TRMPBF](#) [LT6700IDCB-3#TRMPBF](#) [LTC1440IS8#PBF](#) [S-89431ACNC-HBVTFG](#) [NTE1718](#)  
[NTE943](#) [NTE943M](#) [NTE943SM](#) [TA75S393F,LF\(T](#) [ALD2301APAL](#)