

## Low power quad operational amplifier

### Features

- Wide gain bandwidth: 1.3 MHz
- Extended temperature range: -40°C to +150°C
- Input common-mode voltage range includes negative rail
- Large voltage gain: 100 dB
- Very low supply current: 0.7 mA
- 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
- Internal ESD protection:
  - 250 V HBM
  - 150 V MM

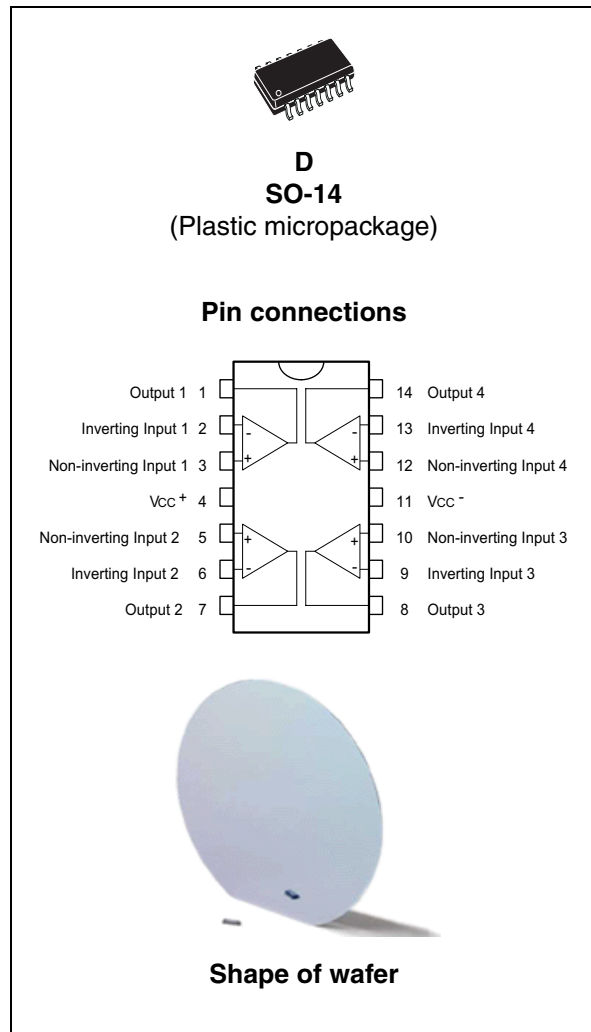
### Applications

- Industrial
- Automotive

### Description

This circuit consists of four independent, high-gain, internally frequency-compensated operational amplifiers, designed specifically for automotive and industrial control systems. It operates 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, the circuit can be directly supplied from a standard +5 V, which is used in logic systems, and will easily provide the required interface electronics without need for 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 a single power supply.

# 1 Schematic diagram

Figure 1. Schematic diagram (1/4 LM2902H)

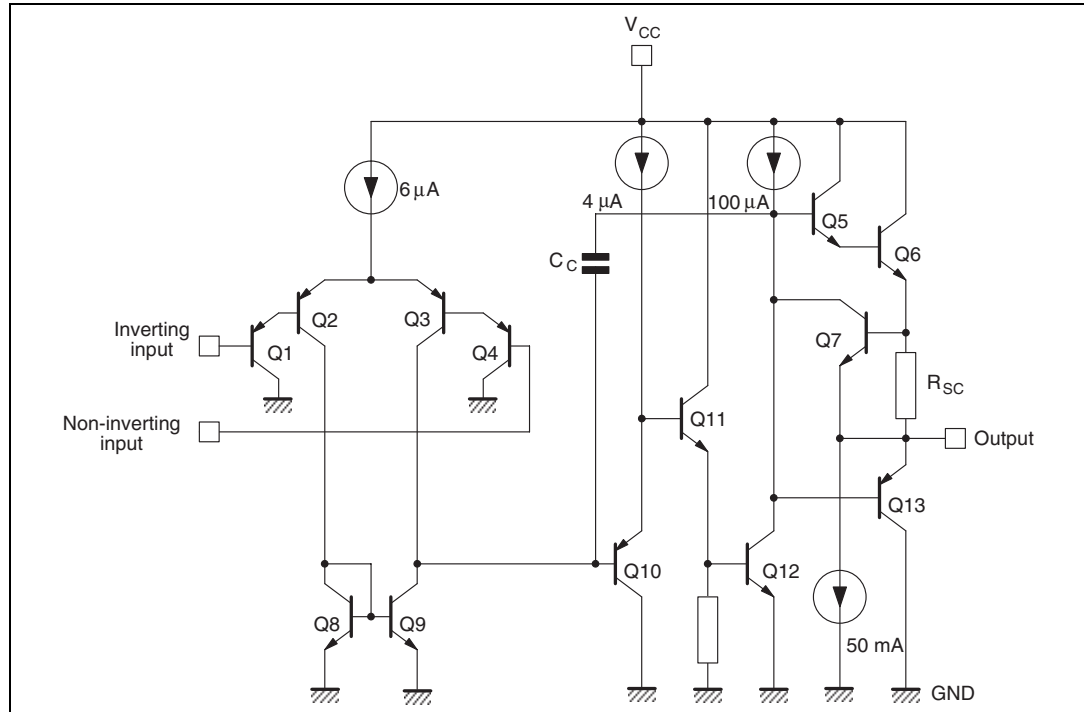
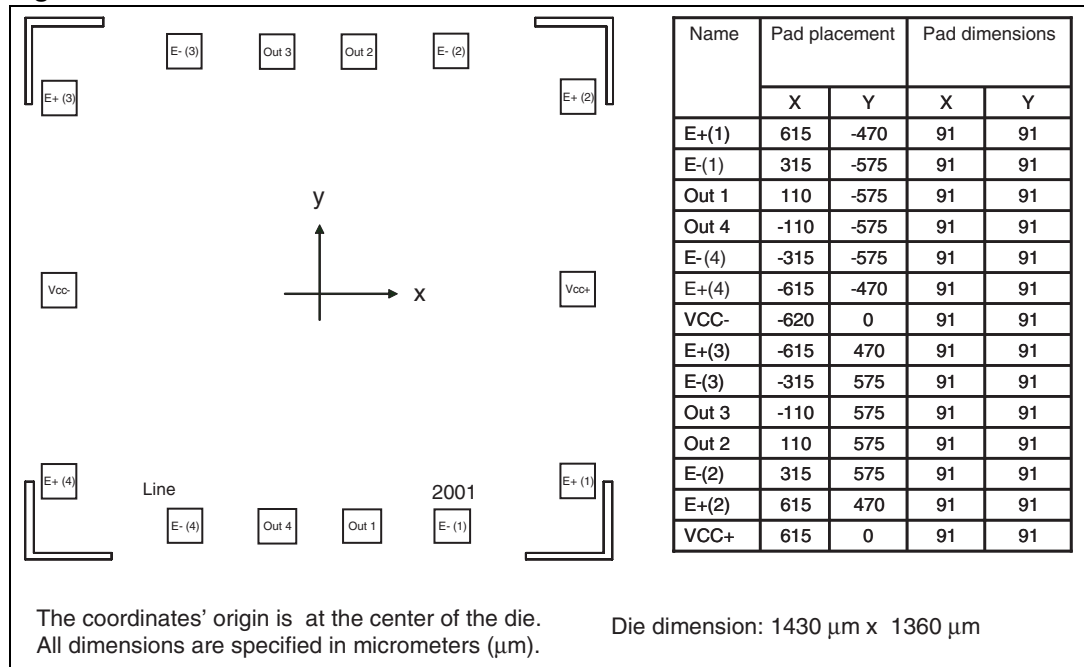


Figure 2. Pad locations



## 2 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply voltage <sup>(1)</sup> ( $V_{CC}^+ - V_{CC}^-$ )	+32	V
$V_{id}$	Differential input voltage <sup>(2)</sup>	+32	V
$V_{in}$	Input voltage	-0.3 to 32	V
	Output short-circuit to ground <sup>(3)</sup>	20	mA
$I_{in}$	Input current <sup>(4)</sup> : $V_{in} < V_{CC}^-$		
	DC	5	mA
	AC (duty cycle = 10 %, T = 1 s)	50	
$T_j$	Maximum junction temperature	150	°C
$R_{thja}$	Thermal resistance junction to ambient <sup>(5)</sup> SO-14	105	°C/W
$R_{thjc}$	Thermal resistance junction to case <sup>(5)</sup> SO-14	31	°C/W
$T_{stg}$	Storage temperature range	-65 to +150	°C
ESD	HBM: human body model <sup>(6)</sup>	370	V
	MM: machine model <sup>(7)</sup>	150	
	CDM: charged device model <sup>(8)</sup>	1500	

- All voltage values, except differential voltages are with respect to ground terminal.
- Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
- Short-circuits from the output to  $V_{CC}$  can cause excessive heating. The maximum output current is approximately 20 mA, independent of the magnitude of  $V_{CC}$ . Destructive dissipation can result from simultaneous short-circuits on all amplifiers.
- 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  $V_{CC}$  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.
- Short-circuits can cause excessive heating and destructive dissipation. Values are typical and for a single layer PCB.
- Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5k $\Omega$  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 other pins are floating.
- Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to the ground.

**Table 2. Operating conditions**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply voltage ( $V_{CC^+} - V_{CC^-}$ )	3 to 30	V
$T_{oper}$	Operating free-air temperature range	-40 to +150	°C
$V_{icm}$	Input common-mode voltage range ( $V_{CC} = 30\text{ V}$ ) <sup>(1)</sup> $T_{amb} = 25^\circ\text{ C}$ $T_{min} \leq T_{amb} \leq T_{max}$	0 to $V_{CC^+} - 1.5$ 0 to $V_{CC^+} - 2$	V

1. 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  $V_{CC^+} - 1.5\text{ V}$ , but either or both inputs can go to +32 V without damage.

### 3 Electrical characteristics

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input offset voltage <sup>(1)</sup> $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		2	7 9	mV
$I_{io}$	Input offset current $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		2	30 40	nA
$I_{ib}$	Input bias current <sup>(2)</sup> $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		20	150 300	nA
$A_{vd}$	Large signal voltage gain $V_{CC} = 15\text{ V}$ , $R_L = 2\text{ k}\Omega$ , $V_O = 1.4\text{ to }11.4\text{ V}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	50 2.5	100		V/mV
SVR	Supply voltage rejection ratio $V_{CC} = 5\text{ to }30\text{ V}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	65 65	110		dB
$I_{cc}$	Supply current, all amps, no load $V_{CC} = 5\text{ V}$ , $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$  $V_{CC} = 30\text{ V}$ , $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		0.7  1.5	1.2 1.2 3 3	mA
CMR	Common-mode rejection ratio $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	70 60	80		dB
$I_{\text{source}}$	Output source current $V_{CC} = 15\text{ V}$ , $V_O = 2\text{ V}$ , $ V_{id}  = 1\text{ V}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	20 10	40	60	mA
$I_{\text{sink}}$	Output sink current $V_O = 2\text{ V}$ , $V_{CC} = 15\text{ V}$ , $ V_{id}  = 1\text{ V}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$  $V_O = 0.2\text{ V}$ , $V_{CC} = 15\text{ V}$ , $ V_{id}  = 1\text{ V}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	10 5  12 10	20		mA   $\mu\text{A}$
$V_{OL}$	Low-level output voltage ( $R_L = 10\text{ k}\Omega$ ) $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		5	20 20	mV
$V_{OH}$	High-level output voltage $V_{CC} = 30\text{ V}$ , $R_L = 2\text{ k}\Omega$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$  $V_{CC} = 30\text{ V}$ , $R_L = 10\text{ k}\Omega$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$  $V_{CC} = 5\text{ V}$ , $R_L = 2\text{ k}\Omega$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	26 26  27 27  3 3.5	27  28		V

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
SR	Slew rate (unity gain) $V_{CC} = 15\text{ V}$ , $V_i = 0.5\text{ to }3\text{ V}$ , $R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	0.2	0.4		V/ $\mu\text{s}$
GBP	Gain bandwidth product $f = 100\text{ kHz}$ $V_{CC} = 30\text{ V}$ , $V_{\text{in}} = 10\text{ mV}$ , $R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	0.7 0.5	1.3		MHz
THD	Total harmonic distortion $f = 1\text{ kHz}$ , $A_V = 20\text{ dB}$ , $R_L = 2\text{ k}\Omega$ , $V_o = 2\text{ V}_{\text{pp}}$ $C_L = 100\text{ pF}$ , $V_{CC} = 30\text{ V}$		0.02		%
$e_n$	Equivalent input noise voltage $f = 1\text{ kHz}$ , $R_S = 100\ \Omega$ , $V_{CC} = 30\text{ V}$		55		nV/ $\sqrt{\text{Hz}}$
$V_{O1}/V_{O2}$	Channel separation <sup>(3)</sup> $1\text{ kHz} \leq f \leq 20\text{ kHz}$		120		dB

- $V_O = 1.4\text{ V}$ ,  $5\text{ V} < V_{CC} < 30\text{ V}$ ,  $0\text{ V} < V_{\text{icm}} < V_{CC}^+ - 1.5\text{ V}$ .
- 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 that stray capacitance does not cause coupling between these external parts. Typically, this can be detected because this type of capacitance increases at higher frequencies.

Figure 3. Large signal voltage gain

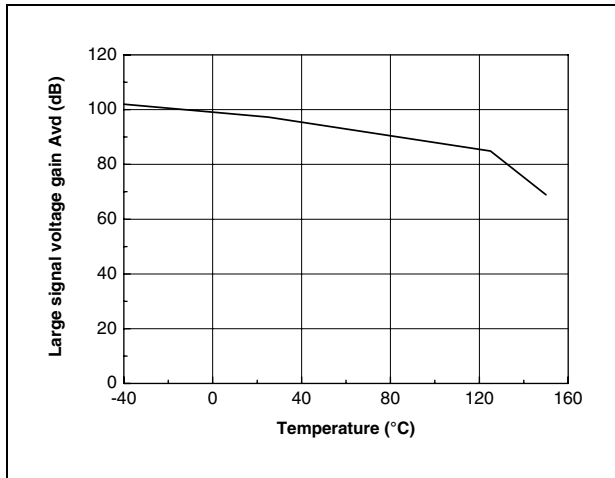


Figure 4. Large signal frequency response

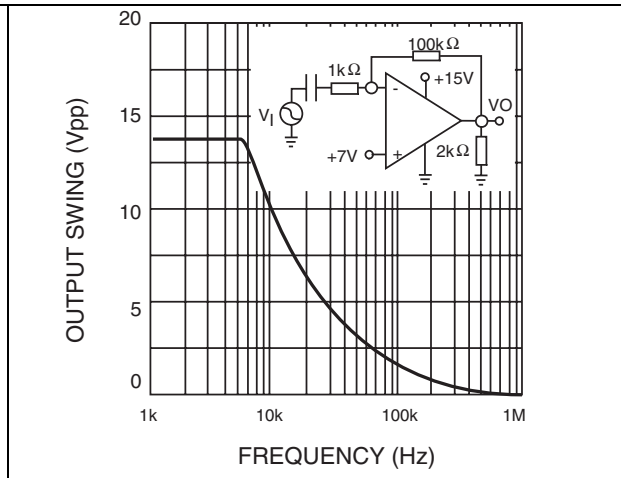


Figure 5. Voltage follower pulse response

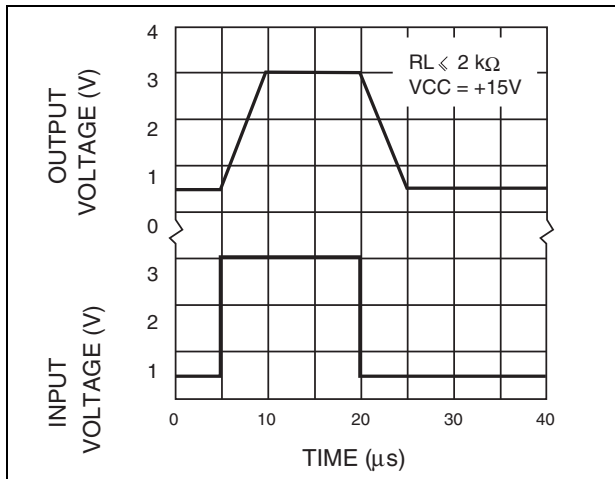


Figure 6. Input bias current

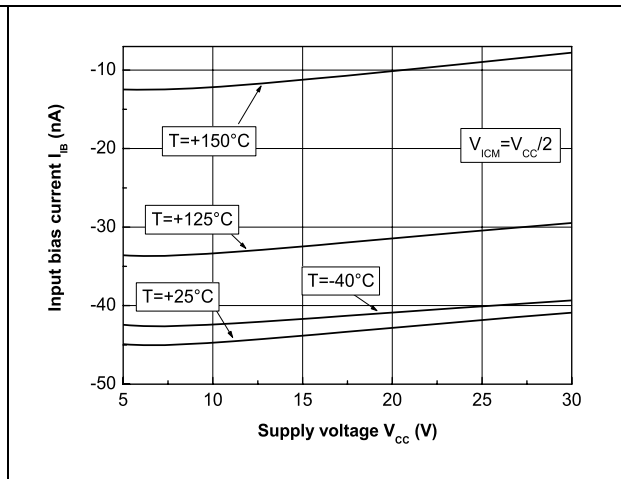


Figure 7. Supply current

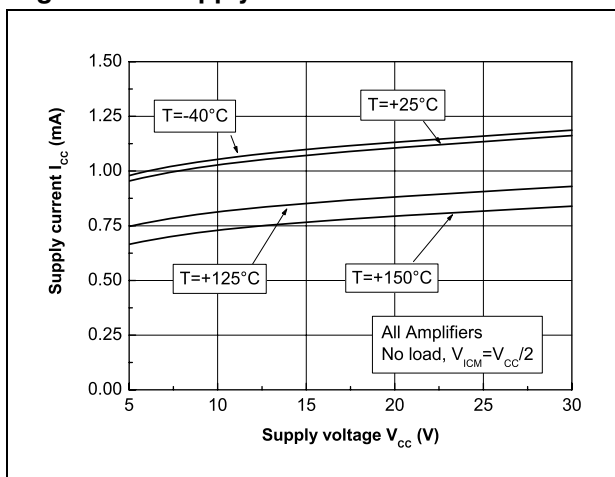


Figure 8. Output characteristics

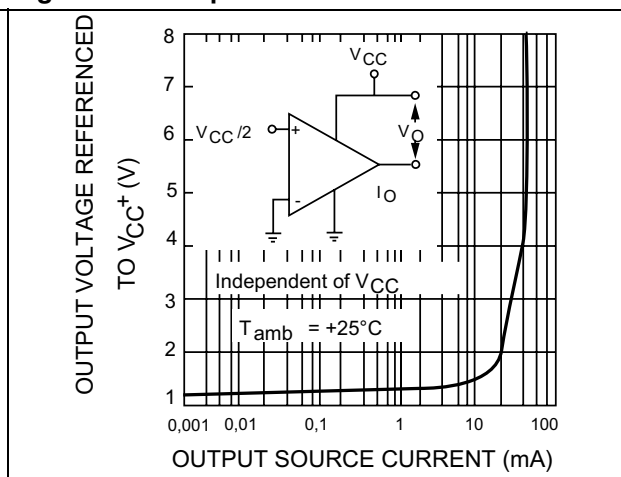


Figure 9. Output characteristics

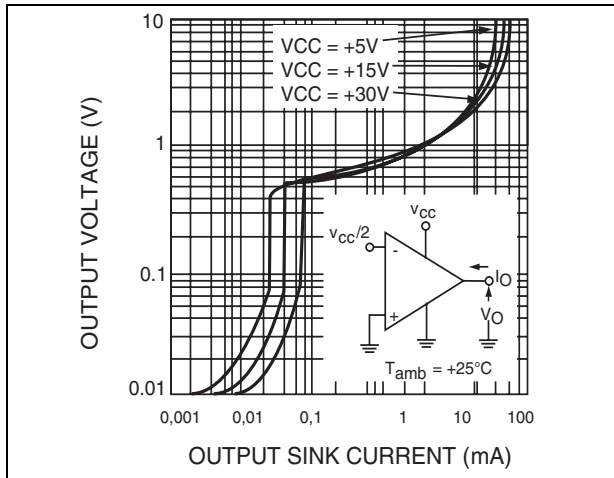


Figure 10. Output current vs temperature

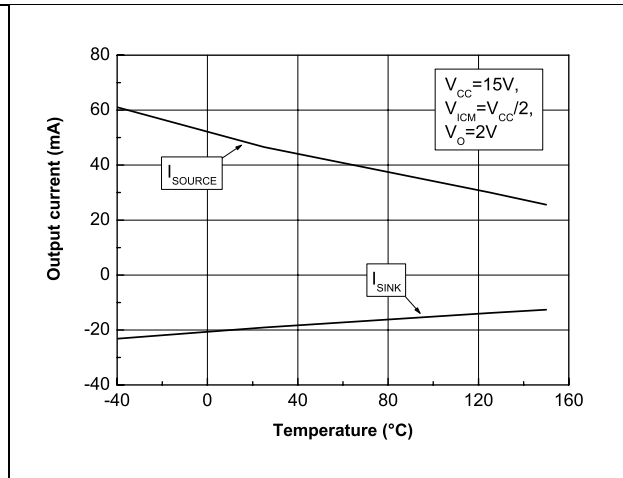


Figure 11. Voltage follower pulse response

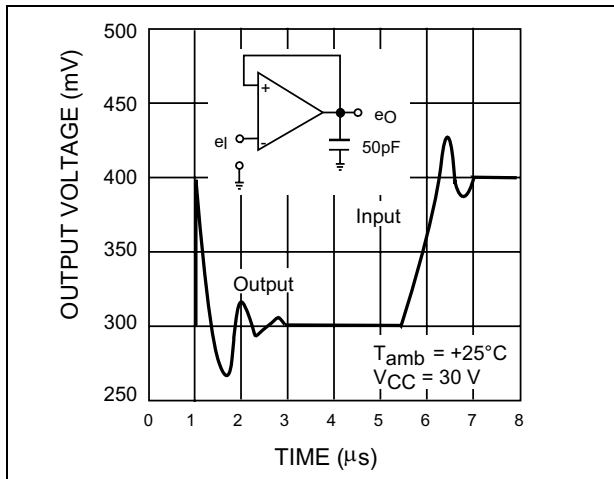


Figure 12. Input voltage range

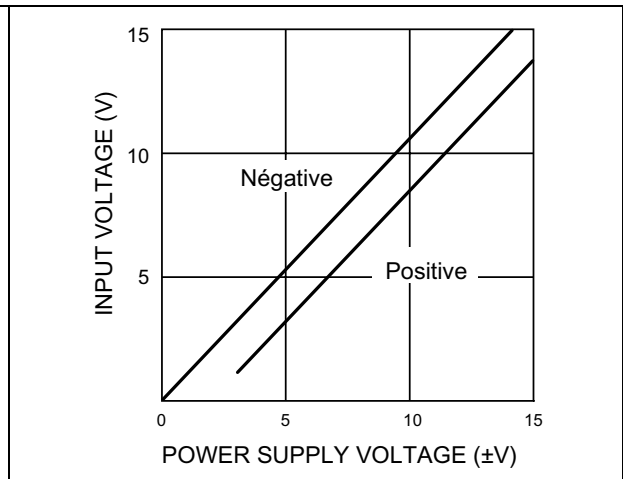


Figure 13. Voltage gain

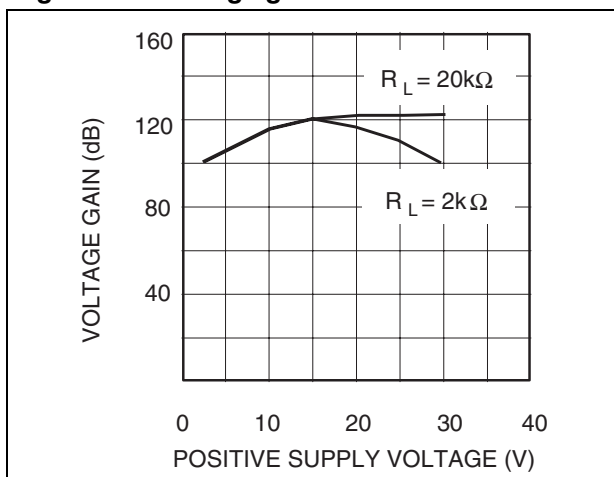


Figure 14. Gain bandwidth product

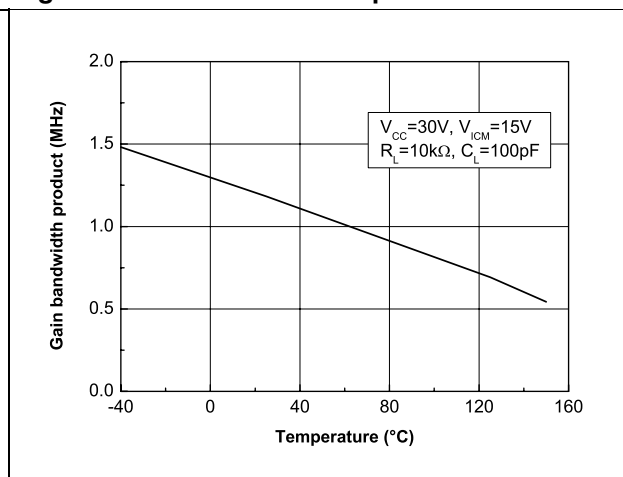




Figure 15. Supply voltage rejection ratio versus temperature

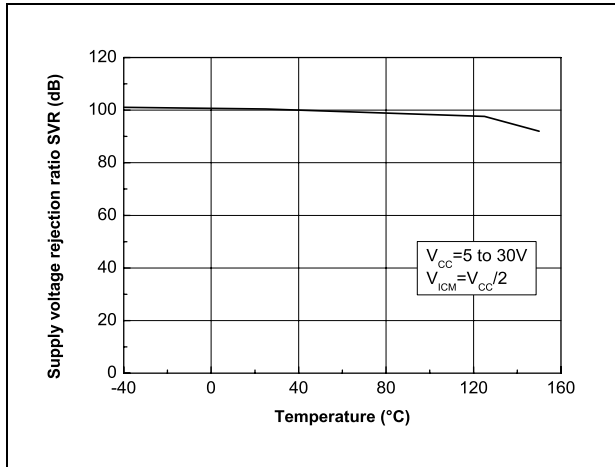


Figure 16. Common-mode rejection ratio versus temperature

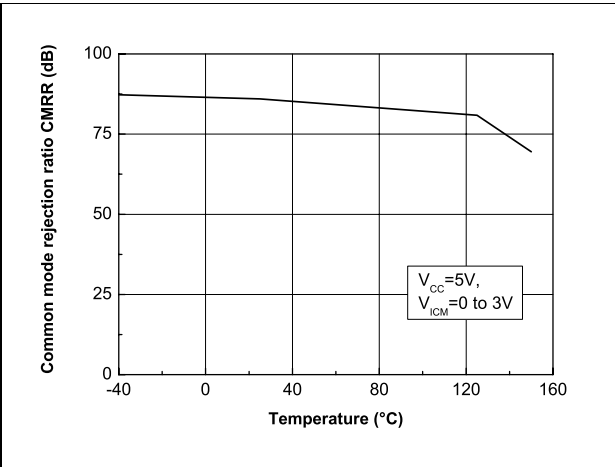
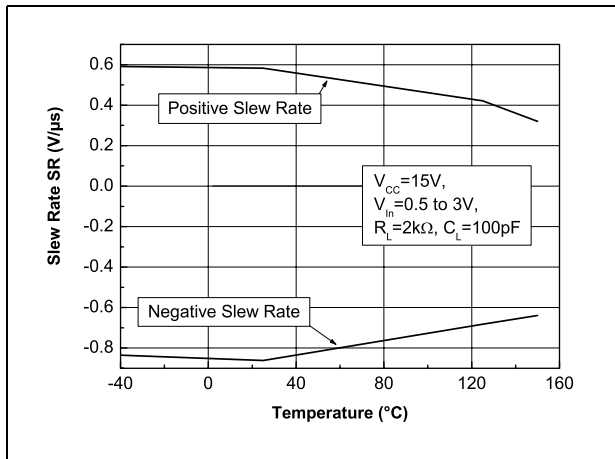


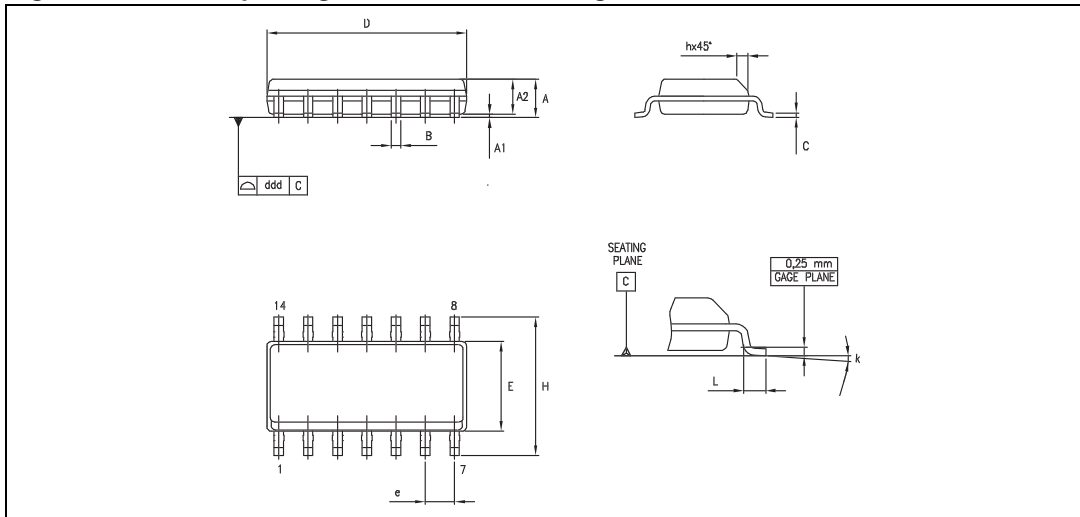
Figure 17. Slew rate versus temperature



## 4 Package information

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

**Figure 18. SO-14 package mechanical drawing**



**Table 4. SO-14 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°C (max.)					
ddd			0.10			0.004

## 5 Ordering information

**Table 5. Order codes**

Order code	Temperature range	Package	Packing	Marking
JLM2902H-CD1	-40° C, +150° C	Wafer		
LM2902HYD <sup>(1)</sup> LM2902HYDT <sup>(1)</sup>		SO-14 (automotive grade)	Tube or tape & reel	2902HY

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

## 6 Revision history

**Table 6. Document revision history**

Date	Revision	Changes
05-Nov-2009	1	Initial release.

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