LM2902H

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: ±1.5 V to ±15 V
- Internal ESD protection:
  - 250 V HBM
  - 150 V MM

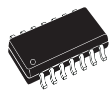
Applications

- Industrial
- Automotive

Description

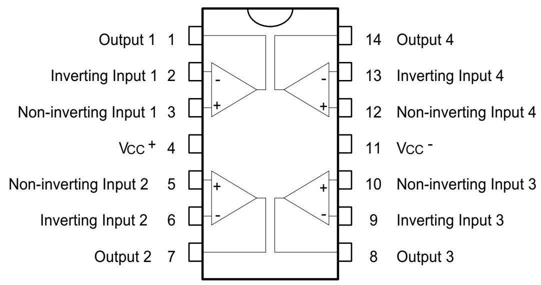
This circuit consists of four independent, high-gain, internally frequency-compensated operational amplifiers, designed specifically for automotive and industrial control systems. It operates from a single power supply over a wide range of voltages. The low power supply drain is independent of the magnitude 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.



D
SO-14
(Plastic micropackage)

Pin connections



Shape of wafer

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)

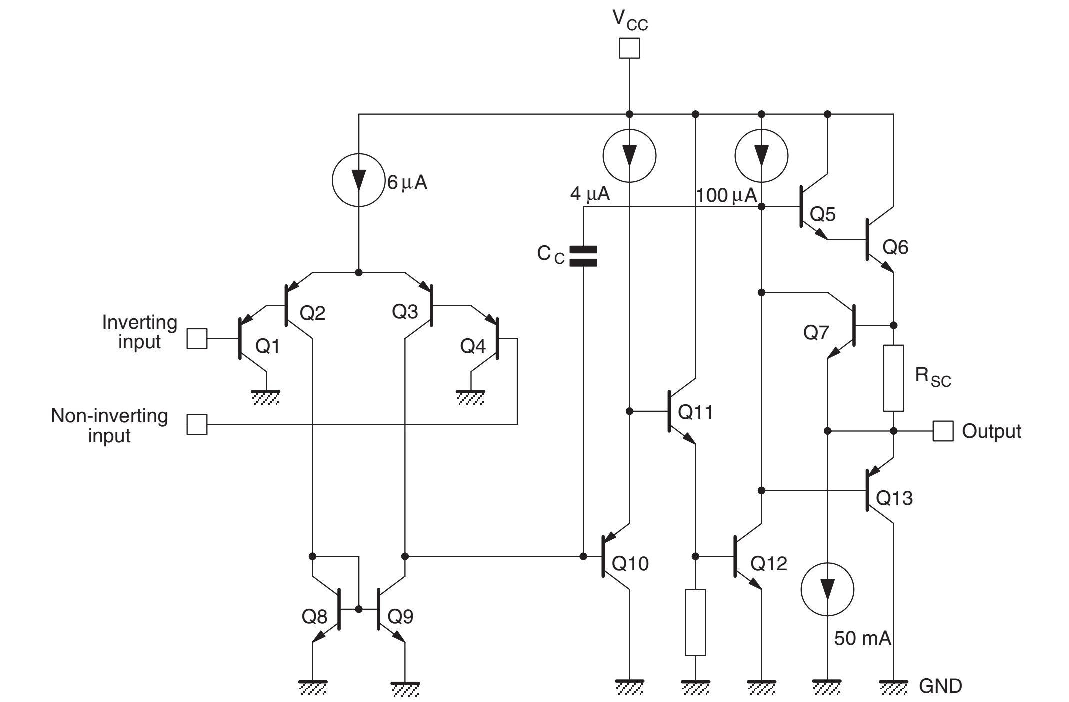
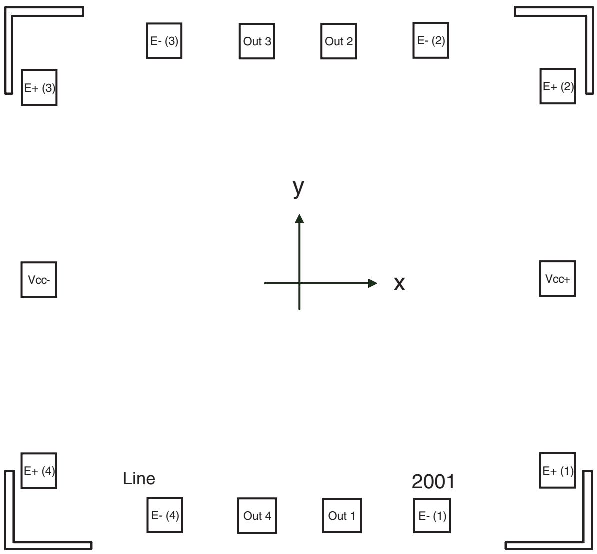


Figure 2. Pad locations



Name	Pad placement		Pad dimensions	
	X	Y	X	Y
E+(1)	615	-470	91	91
E-(1)	315	-575	91	91
Out 1	110	-575	91	91
Out 4	-110	-575	91	91
E-(4)	-315	-575	91	91
E+(4)	-615	-470	91	91
VCC-	-620	0	91	91
E+(3)	-615	470	91	91
E-(3)	-315	575	91	91
Out 3	-110	575	91	91
Out 2	110	575	91	91
E-(2)	315	575	91	91
E+(2)	615	470	91	91
VCC+	615	0	91	91

The coordinates' origin is at the center of the die.
All dimensions are specified in micrometers (µm).

Die dimension: 1430 µm x 1360 µm

2 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

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

1. All voltage values, except differential voltages are with respect to ground terminal.
2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
3. 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.
4. 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.
5. Short-circuits can cause excessive heating and destructive dissipation. Values are typical and for a single layer PCB.
6. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
7. 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 Ω). This is done for all couples of connected pin combinations while other pins are floating.
8. 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 V)(1) T_{amb} = 25° 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 V, but either or both inputs can go to +32 V without damage.

3 Electrical characteristics

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

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

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

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

1. $V_O = 1.4$ V, 5 V < V_{CC} < 30 V, 0 V < V_{icm} < 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 loading charge on the input lines.
3. 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

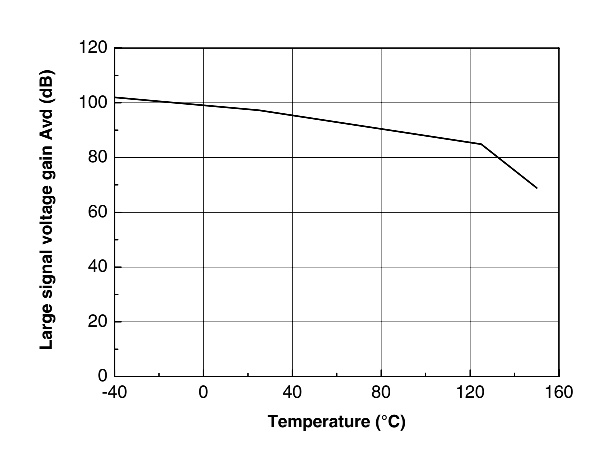


Figure 4. Large signal frequency response

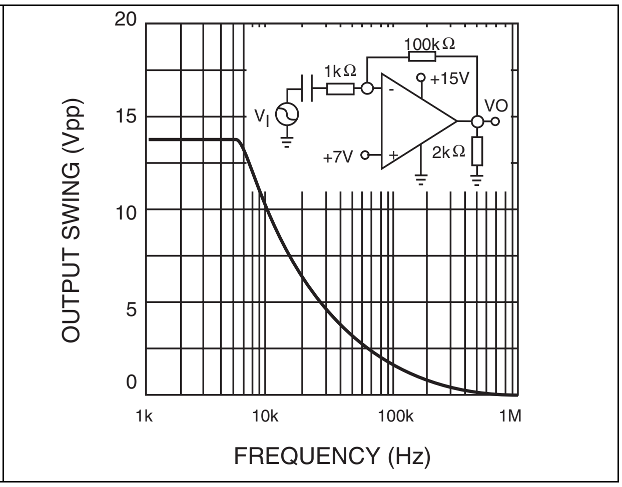


Figure 5. Voltage follower pulse response

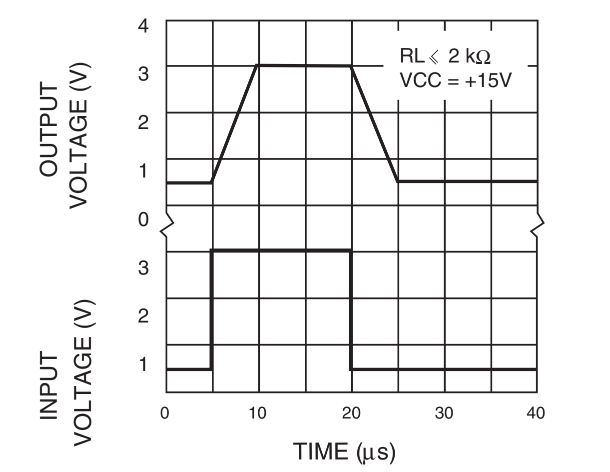


Figure 6. Input bias current

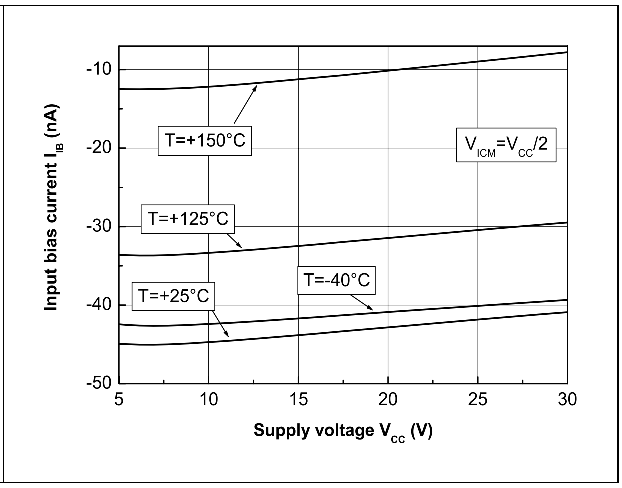


Figure 7. Supply current

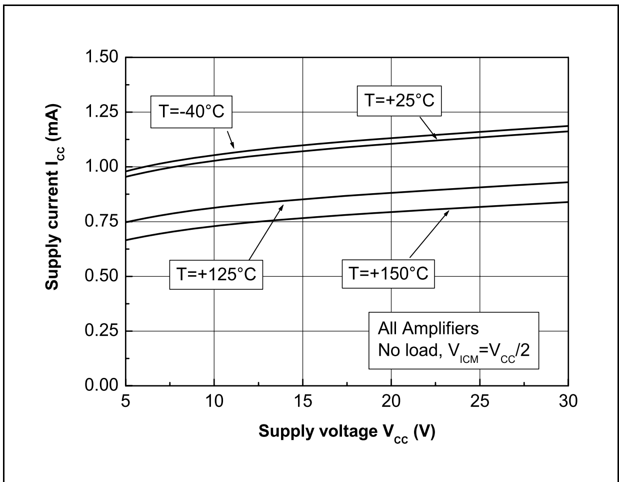


Figure 8. Output characteristics

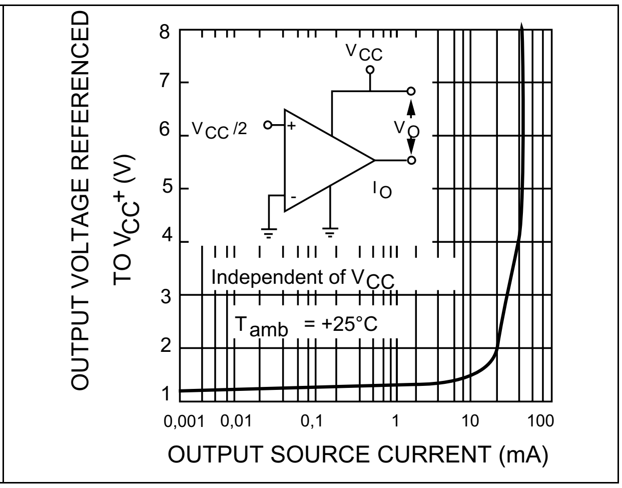


Figure 9. Output characteristics

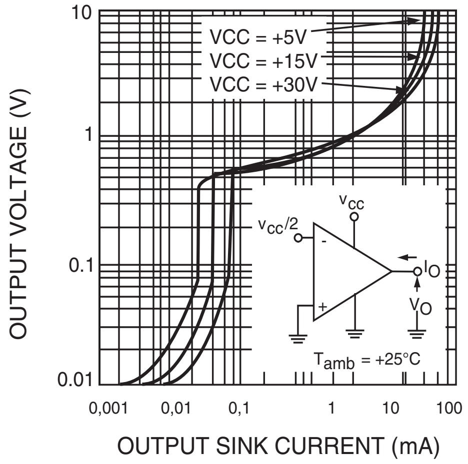


Figure 10. Output current vs temperature

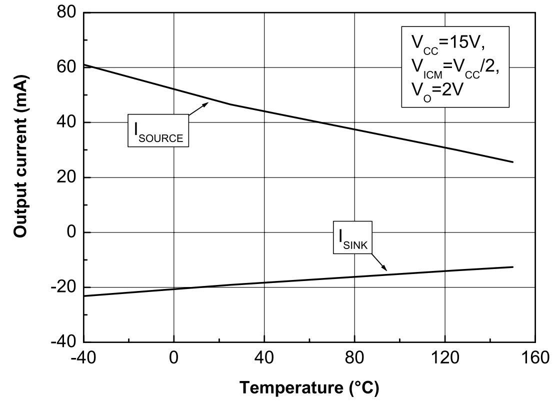


Figure 11. Voltage follower pulse response

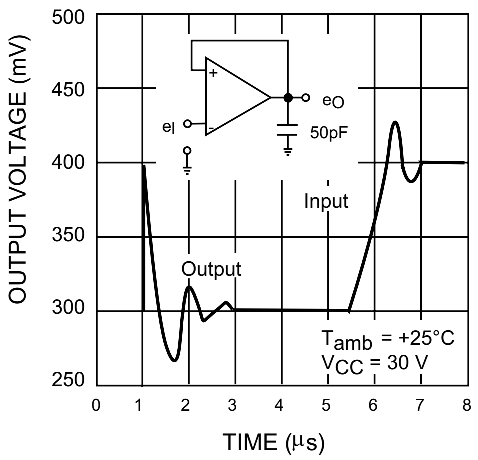


Figure 12. Input voltage range

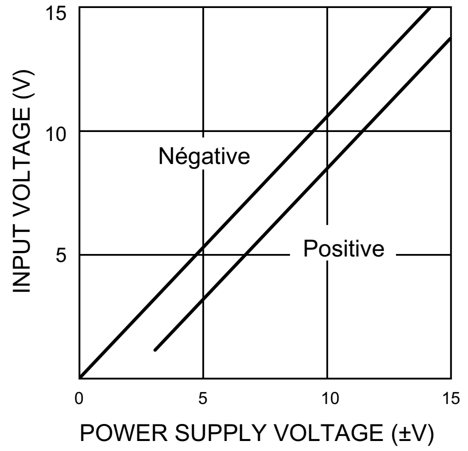


Figure 13. Voltage gain

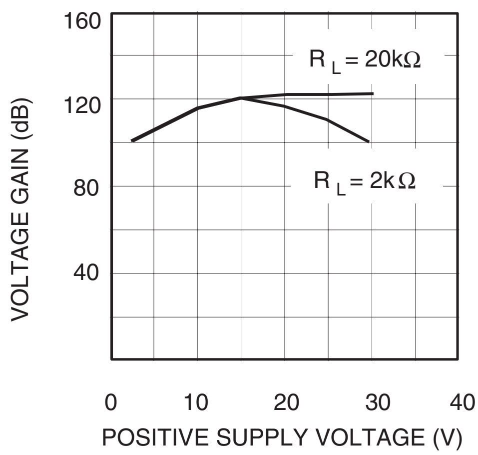


Figure 14. Gain bandwidth product

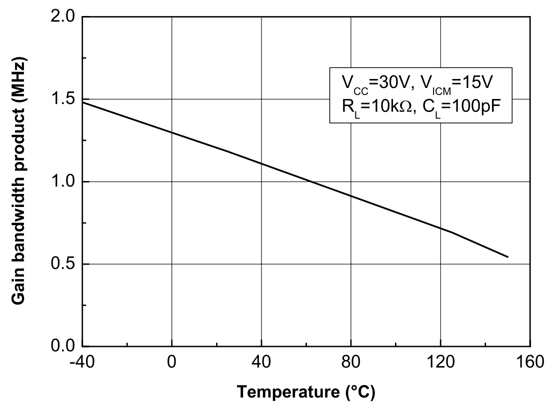


Figure 15. Supply voltage rejection ratio versus temperature

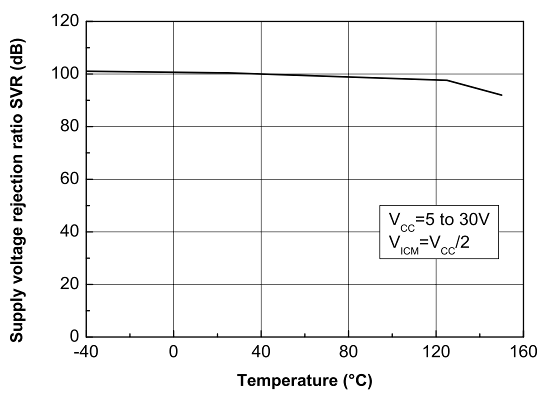


Figure 16. Common-mode rejection ratio versus temperature

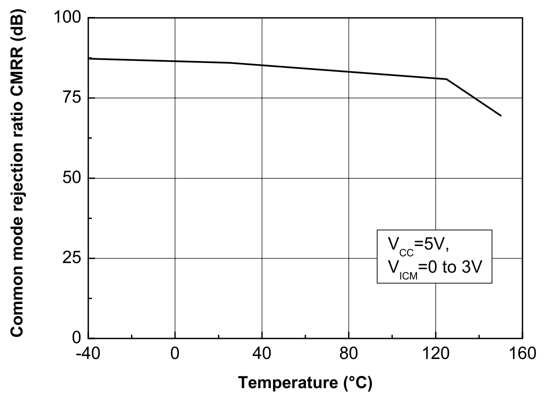
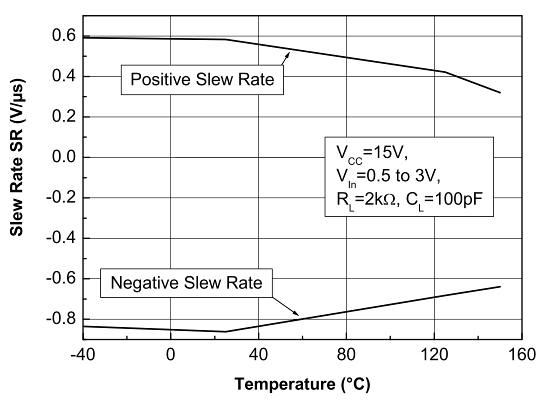


Figure 17. Slew rate versus temperature



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*. ECOPACK® is an ST trademark.

Figure 18. SO-14 package mechanical drawing

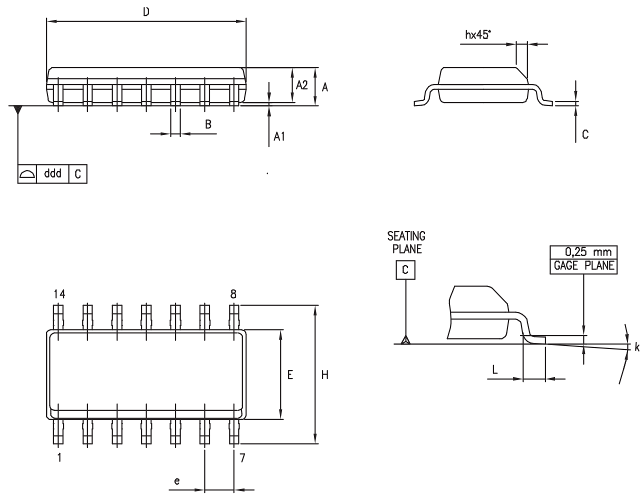


Table 4. SO-14 package mechanical data

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[1] LM2902HYDT[1]		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.