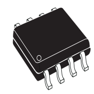
LM2904WH

Low power dual operational amplifier

Features

- Internally frequency-compensated
- Large DC voltage gain: 100dB
- Wide bandwidth (unity gain: 1.1MHz temperature-compensated)
- Very low supply current per operator (500µA)
- Low input bias current: 20nA (temperature-compensated)
- Low input offset current: 2nA
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0V to V_{CC} - 1.5V
- Internal ESD protection:
  - 2kV HBM
  - 200V MM



D
SO-8
(Plastic micropackage)

Wafer form

Description

This circuit consists of two 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 now can be more easily implemented in single power supply systems. For example, these circuits can be directly supplied from standard +5V which is used in logic systems and will easily provide the required interface electronics without requiring 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 (1/2 LM2904WH)

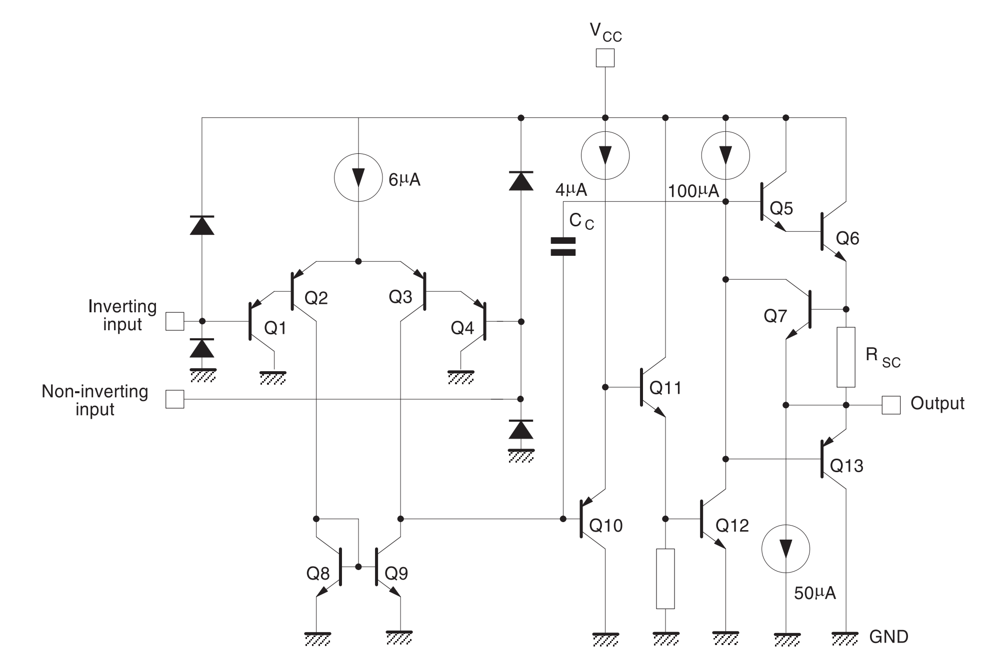
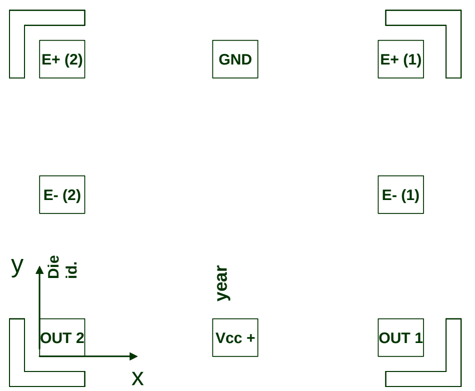


Figure 2. Pad locations



Name	Pad placement		Pad dimensions	
	X	Y	X	Y
GND	480	1040	102	102
E+1	940	1030	102	102
E-1	1010	620	102	102
OUT1	910	55	102	102
Vcc +	480	70	102	102
OUT2	55	55	102	102
E-2	-30	620	102	102
E+2	-30	1030	102	102

The origin coordinate is at the bottom left part of the OUT2 pin. All dimensions are specified in micrometers (µm).

2 Absolute maximum ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}^+	Supply voltage	+32	V
V_{ID}	Differential input voltage	-0.3 to V_{CC}+0.3	V
V_I	Input voltage	-0.3 to V_{CC}+0.3	V
	Output short-circuit to ground(1)	40	mA
P_d	Power dissipation at T_{amb}=+25°C (2)	1	W
I_{in}	Input current (3)	5	mA
T_{stg}	Storage temperature range	-65 to +150	°C
ESD	HBM: human body model(4)	2	kV
	MM: machine model(5)	200	V
	CDM: charged device model(6)	1.5	kV

1. Short-circuits from the output to V_{CC} can cause excessive heating if V_{CC}^+ > 15V. The maximum output current is approximately 40mA, independent of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short-circuits on all amplifiers.
2. P_d is calculated with T_{amb} = +25°C, $T_{Junction}$ = +150°C and R_{thja} = 125°C/W for the SO-8 package.
3. This input current only exists when the voltage values applied on the inputs is beyond the supply voltage line limits. This is not destructive if the current does not exceed 5mA as indicated, and normal output will be restored for input voltages above -0.3V.
4. Human body model: 100pF discharged through a 1.5kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
5. Machine model: a 200pF cap is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5Ω), done for all couples of pin combinations with other pins floating.
6. 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	3 to 30	V
T_{oper}	Operating free-air temperature range	-40 to +150	°C

3 Electrical characteristics

Table 3. $V_{CC}^+ = 5V$, $V_{CC}^- =$ Ground, $V_o = 1.4V$, $T_{amb} = 25°C$ (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	150 200	nA
A_{vd}	Large signal voltage gain $V_{CC}^+ = +15V, R_L = 2k\Omega, V_o = 1.4V$ to $11.4V$ $T_{min} \le T_{amb} \le T_{max}$	50 2.5	100		V/mV
SVR	Supply voltage rejection ratio $V_{CC}^+ = +5$ to $+30V$, $R_S \le 10k\Omega$ $T_{min} \le T_{amb} \le T_{max}$	65 65	100		dB
I_{CC}	Supply current, all amps, no load $T_{amb} = 25°C$, $V_{CC}^+ = +5V$ $T_{min} \le T_{amb} \le T_{max}$, $V_{CC} = +30V$		0.7	1.2 2	mA
V_{icm}	Input common mode voltage range ($V_{CC}^+ = +30V$)[3] $T_{min} \le T_{amb} \le T_{max}$	0 0		$V_{CC}^+ -1.5$ $V_{CC}^+ -2$	V
CMR	Common-mode rejection ratio ($R_S = 10k\Omega$) $T_{min} \le T_{amb} \le T_{max}$	70 60	85		dB
I_{source}	Output short-circuit current $V_{CC}^+ = +15V$, $V_o = +2V$, $V_{id} = +1V$ $T_{min} \le T_{amb} \le T_{max}$	20 10	40	60	mA
I_{sink}	Output sink current $V_O = 2V$, $V_{CC}^+ = +5V$ $T_{min} \le T_{amb} \le T_{max}$ $V_O = +0.2V$, $V_{CC}^+ = +15V$ $T_{min} \le T_{amb} \le T_{max}$	10 5 12 10	20 50		mA µA
V_{OPP}	Output voltage swing ($R_L = 2k\Omega$) $T_{min} \le T_{amb} \le T_{max}$	0 0		$V_{CC}^+ -1.5$ $V_{CC}^+ -2$	V
V_{OH}	High level output voltage ($V_{CC}^+ = +30V$) $T_{amb} = +25°C$, $R_L = 2k\Omega$ $T_{min} \le T_{amb} \le T_{max}$. $T_{amb} = +25°C$, $R_L = 10k\Omega$ $T_{min} \le T_{amb} \le T_{max}$	26 26 27 27	27 28		V
V_{OL}	Low level output voltage ($R_L = 10k\Omega$) $T_{min} \le T_{amb} \le T_{max}$		5	20 20	mV

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
SR	Slew rate (unity gain) V_{CC}^+ = 15V, Vi = 0.5 to 3V, R_L = 2kΩ, C_L = 100pF, $T_{min} \le T_{amb} \le T_{max}$	0.3 0.2	0.6		V/µs
GBP	Gain bandwidth product f = 100kHz V_{CC}^+ = 30V, V_{in} = 10mV, R_L = 2kΩ, C_L = 100pF $T_{min} \le T_{amb} \le T_{max}$	0.7 0.45	1.1		MHz
THD	Total harmonic distortion f = 1kHz, A_V = 20dB, R_L = 2kΩ, V_o = 2V_{pp}, C_L = 100pF, V_{CC} = 30V		0.02		%
e_n	Equivalent input noise voltage f = 1kHz, R_S = 100Ω, V_{CC} = 30V		55		$nV/\sqrt{Hz}$
DV_{io}	Input offset voltage drift		7	30	µV/°C
DI_{io}	Input offset current drift		10	300	pA/°C
V_{O1}/V_{O2}	Channel separation (4) $1kHz \le f \le 20kHz$		120		dB

1. V_O = 1.4V, R_S = 0Ω, 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 there is no change in the loading charge 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, ensure that stray capacitancedoes not cause coupling between these external parts. Typically, this can be detected because this type of capacitance increases at higher frequencies.

Figure 3. Open loop frequency response

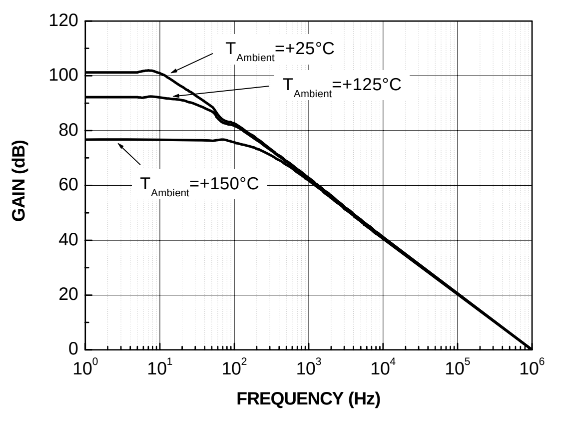


Figure 4. Large signal frequency response

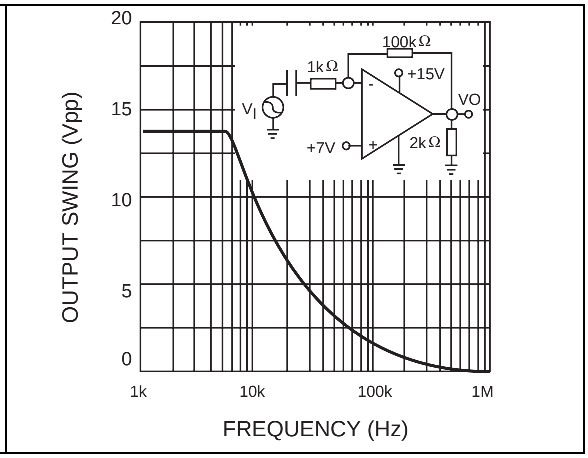


Figure 5. Voltage follower pulse response

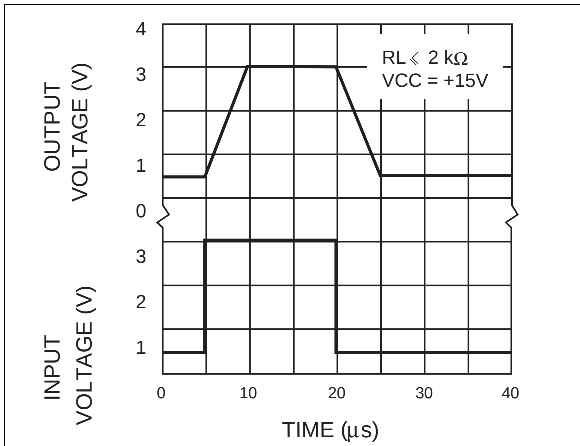


Figure 6. Input bias current

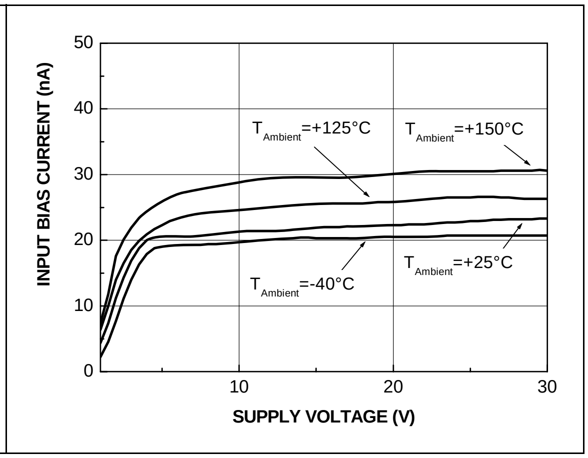


Figure 7. Supply current

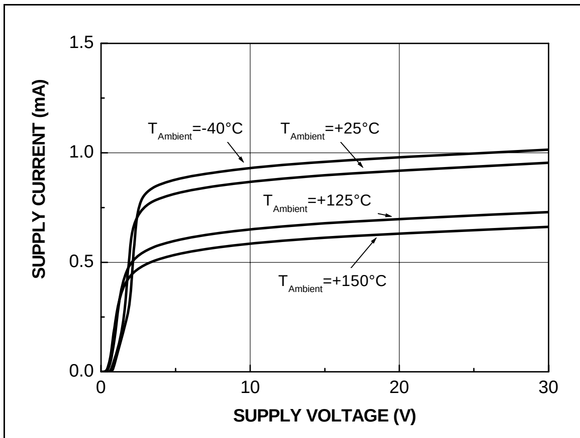


Figure 8. Output characteristics

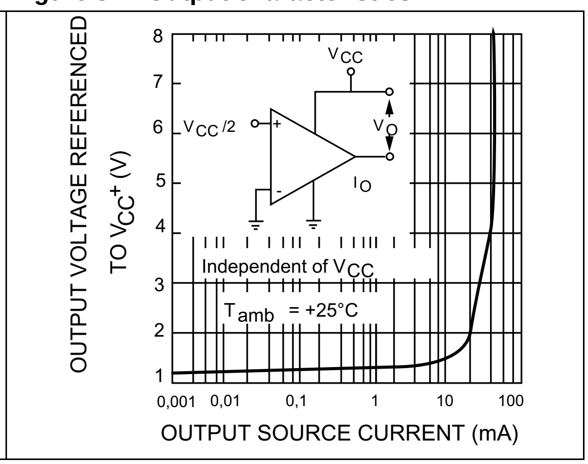


Figure 9. Output characteristics

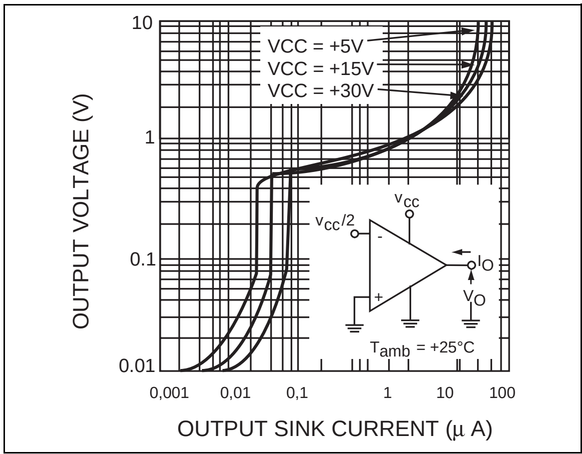


Figure 10. Current limiting

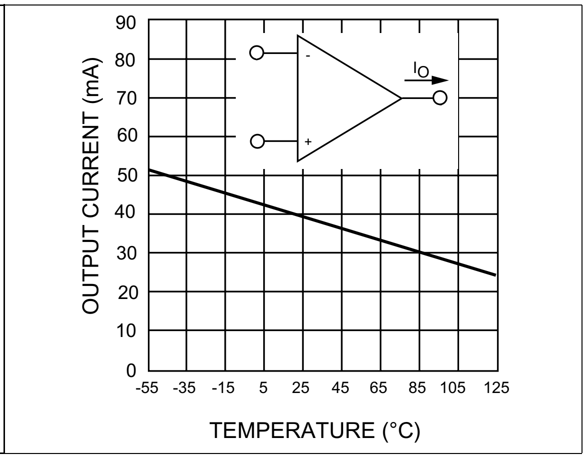


Figure 11. Voltage follower pulse response

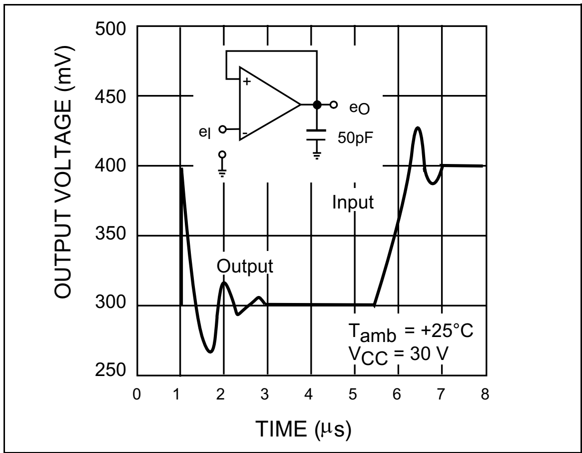


Figure 12. Input voltage range

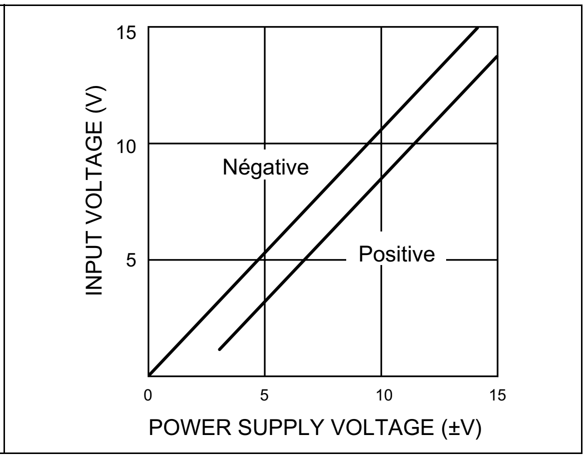


Figure 13. Voltage gain

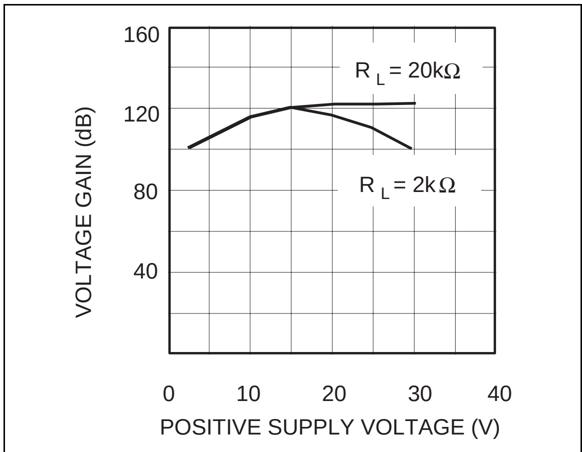


Figure 14. Gain bandwidth product

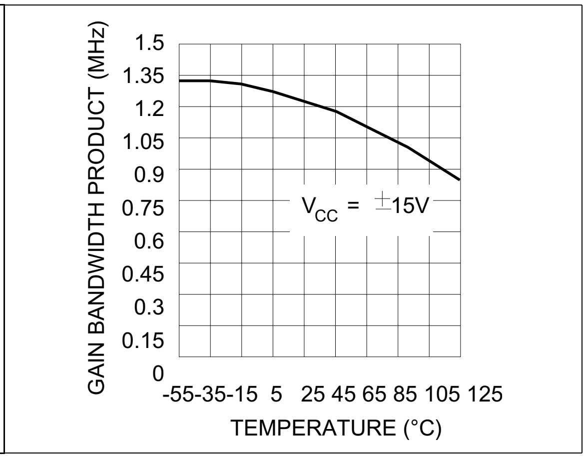


Figure 15. Power supply rejection ratio versus temperature

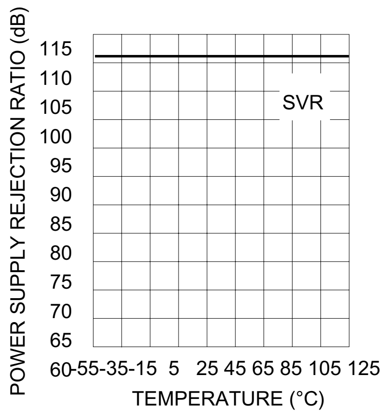
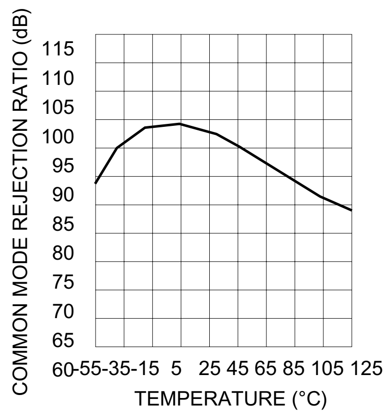


Figure 16. Common mode rejection ratio versus temperature

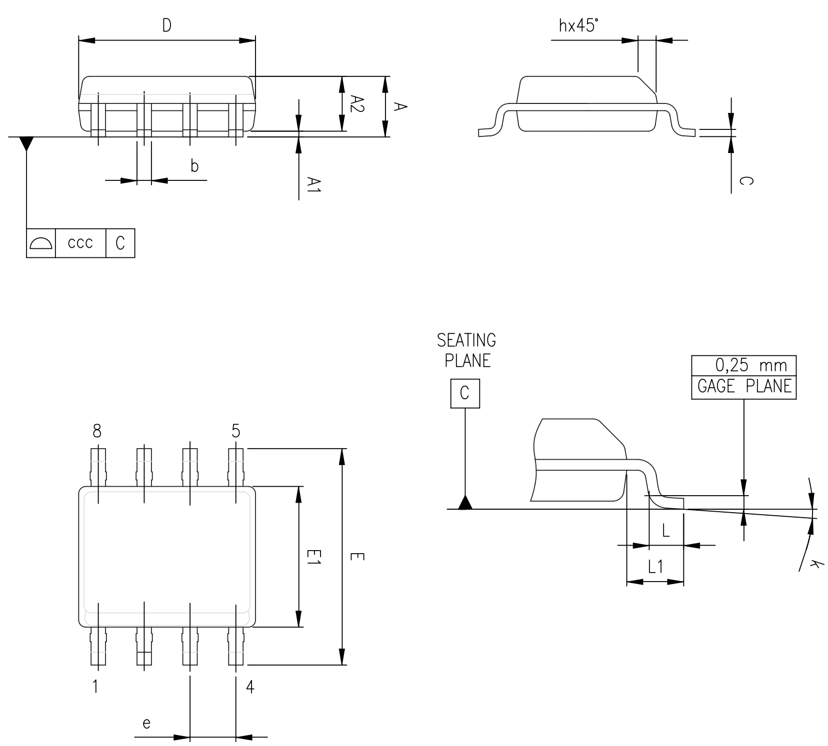


4 Package information

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

Figure 17. SO-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
H	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	1°		8°	1°		8°
ccc			0.10			0.004



5 Ordering information

Table 4. Order codes

Part number	Temperature range	Package	Packing	Marking
JLM2904WH-CD1	-40°C, +150°C	Wafer		
LM2904WHD LM2904WHDT		SO-8	Tube or tape & reel	2904WH
LM2904WHYD LM2904WHYDT(1)		SO-8 (Automotive grade level)	Tube or tape & reel	2904WY

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

Date	Revision	Changes
1-Sep-2003	1	Initial release.
1-Jul-2005	2	PPAP references inserted in the datasheet, see *Section 5: Ordering information*.
1-Oct-2005	3	Correction of error in A_{VD} min. value in *Table 3*. Minor grammatical and formatting changes throughout.
27-Sep- 2006	4	Correction of error in A_{VD} min. value in *Table 3*.
20-Jul-2007	5	ESD values added in *Table 1: Absolute maximum ratings*. Equivalent input noise parameter added in *Table 3*. Electrical characteristics curves updated. *Section 4: Package information* updated.

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