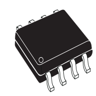
LM2904WH

Low power dual operational amplifier

Features

- Internally frequency compensated
- Large DC voltage gain: 100 dB
- Wide bandwidth (unity gain: 1.1 MHz temperature compensated)
- Very low supply current per operator (500 µA)
- Low input bias current: 20 nA (temperaturecompensated)
- Low input offset current: 2 nA
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0 V to V_{CC} - 1.5 V
- Internal ESD protection:
  - 2 kV HBM
  - 200 V 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 +5 V 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)

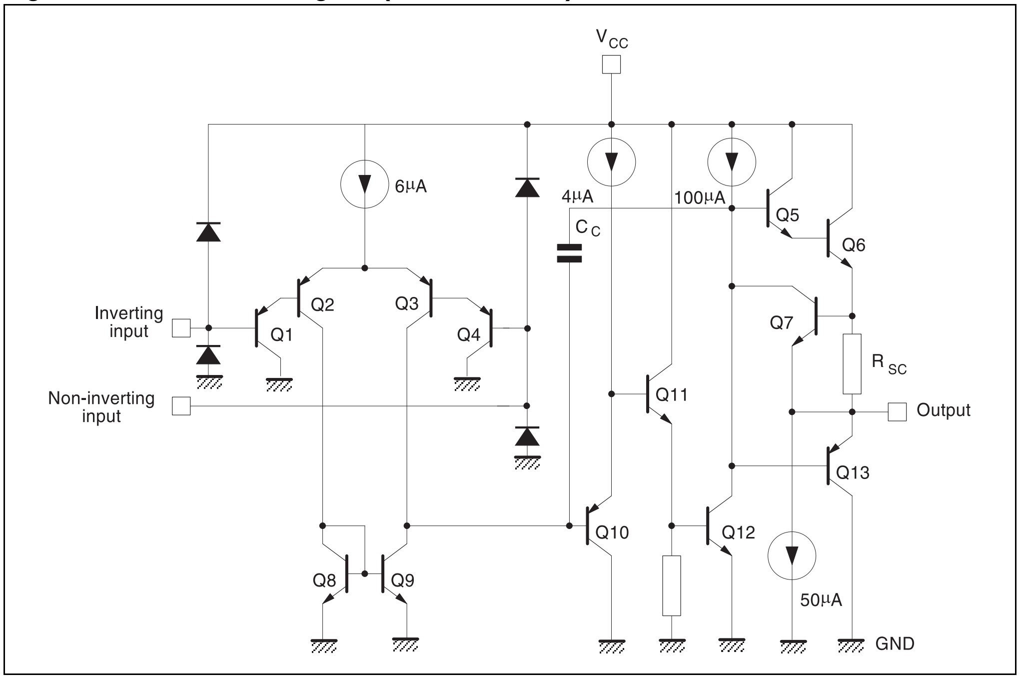
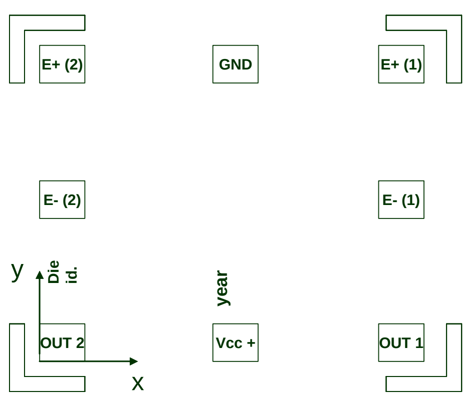


Figure 2. Pad locations



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 and operating conditions

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_{in}	Input voltage	-0.3 to V_{CC}+0.3	V
	Output short-circuit to ground(1)	40	mA
T_j	Maximum junction temperature	150	°C
R_{thja}	Thermal resistance junction to ambient (2) SO-8	125	°C/W
R_{thjc}	Thermal resistance junction to case (2) SO-8	40	°C/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}^+ > 15 V. The maximum output current is approximately 40 mA, independent of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short-circuits on all amplifiers.
2. Short-circuits can cause excessive heating and destructive dissipation. Values are typical.
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 5 mA as indicated, and normal output is restored for input voltages above -0.3V.
4. Human body model: A 100pF 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.
5. Machine model: A 200pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5Ω). This is done for all couples of connected pin combinations while the other pins are floating.
6. 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
T_{oper}	Operating free-air temperature range	-40 to +150	°C
V_{icm}	Input common mode voltage range (V_{CC}^+=+30V)(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}^{+} = 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) $T_{min} \leq T_{amb} \leq T_{max}$		2	7 9	mV
I_{io}	Input offset current $T_{min} \leq T_{amb} \leq T_{max}$		2	30 40	nA
I_{ib}	Input bias current (2) $T_{min} \leq T_{amb} \leq T_{max}$		20	150 200	nA
A_{vd}	Large signal voltage gain V_{CC}^{+} = +15V,R_L=2kΩ, V_o = 1.4V to 11.4V $T_{min} \leq T_{amb} \leq T_{max}$	50 2.5	100		V/mV
SVR	Supply voltage rejection ratio V_{CC}^{+} = +5 to +30V, $R_S \leq$ 10kΩ $T_{min} \leq T_{amb} \leq T_{max}$	65 65	100		dB
I_{CC}	Supply current, all amps, no load V_{CC}^{+} = +5V $T_{min} \leq T_{amb} \leq T_{max}$, V_{CC} = +30V		0.7	1.2 2	mA
CMR	Common-mode rejection ratio (R_S = 10kΩ) $T_{min} \leq T_{amb} \leq T_{max}$	70 60	85		dB
I_{source}	Output short-circuit current V_{CC}^{+}= +15V, V_o = +2V, V_{id} = +1V $T_{min} \leq T_{amb} \leq T_{max}$	20 10	40	60	mA
I_{sink}	Output sink current V_O = 2V, V_{CC}^{+} = +5V $T_{min} \leq T_{amb} \leq T_{max}$ V_O = +0.2V, V_{CC}^{+} = +15V $T_{min} \leq T_{amb} \leq T_{max}$	10 5 12 10	20 50		mA µA
V_{OPP}	Output voltage swing (R_L = 2kΩ) $T_{min} \leq T_{amb} \leq T_{max}$	0 0		V_{CC}^{+} -1.5 V_{CC}^{+} -2	V
V_{OH}	High level output voltage (V_{CC}^{+} = + 30V) R_L = 2kΩ $T_{min} \leq T_{amb} \leq T_{max}$ R_L = 10kΩ $T_{min} \leq T_{amb} \leq T_{max}$	26 26 27 27	27 28		V
V_{OL}	Low level output voltage (R_L = 10kΩ) $T_{min} \leq T_{amb} \leq T_{max}$		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, $T_{min} \leq T_{amb} \leq T_{max}$	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 $T_{min} \leq T_{amb} \leq T_{max}$	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/√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 (3) 1kHz ≤ f ≤ 20kHz		120		dB

1. V_O = 1.4 V, R_S = 0 Ω, 5 V < V_{CC}^+ < 30 V, 0 V < V_{ic} < 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. Open loop frequency response

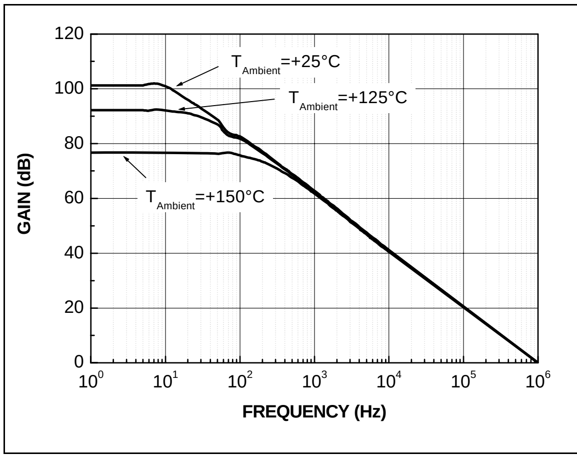


Figure 4. Large signal frequency response

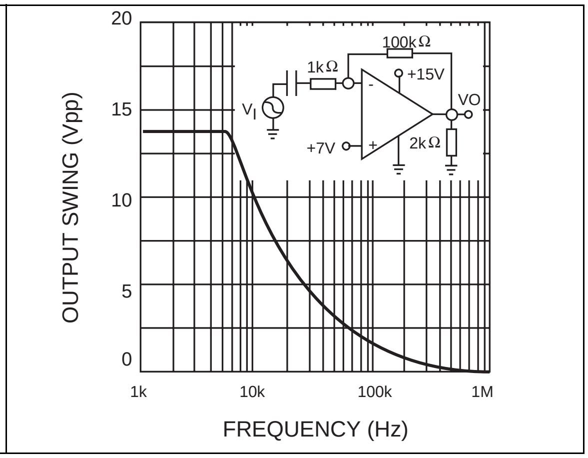


Figure 5. Voltage follower pulse response

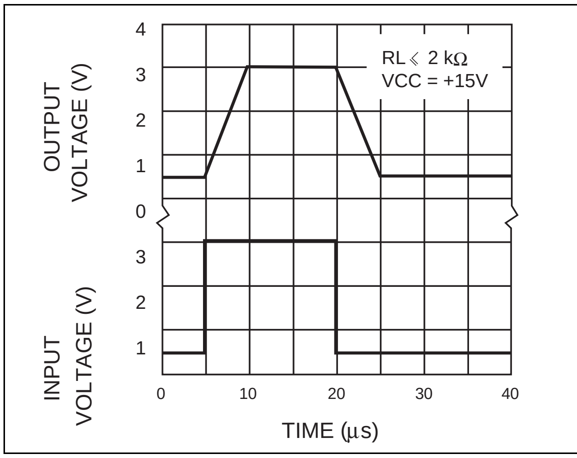


Figure 6. Input bias current

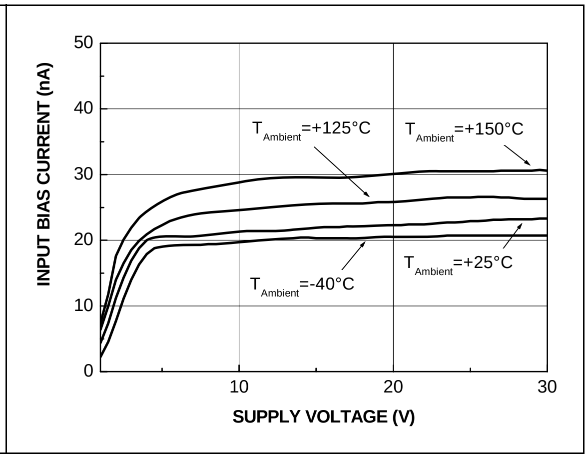


Figure 7. Supply current

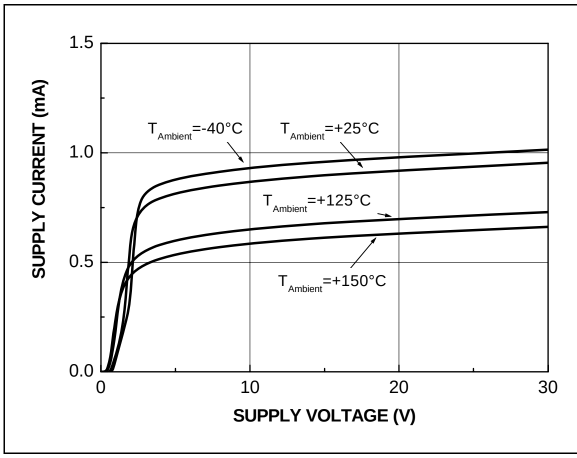


Figure 8. Output characteristics

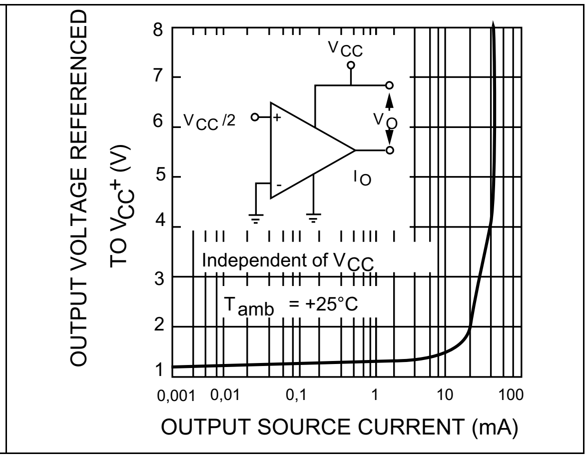


Figure 9. Output characteristics

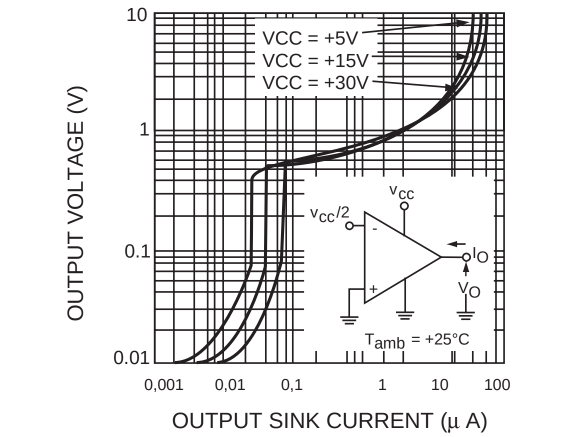


Figure 10. Current limiting

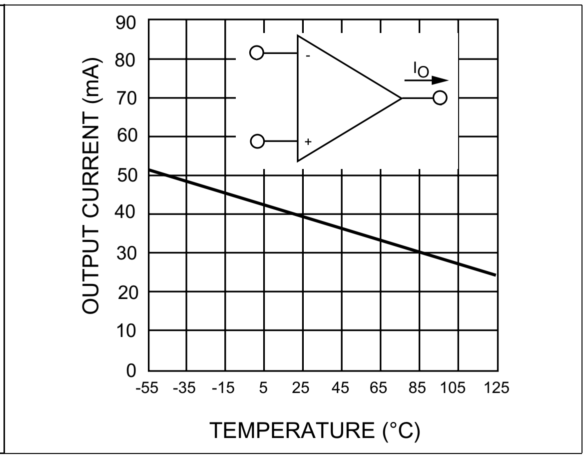


Figure 11. Voltage follower pulse response

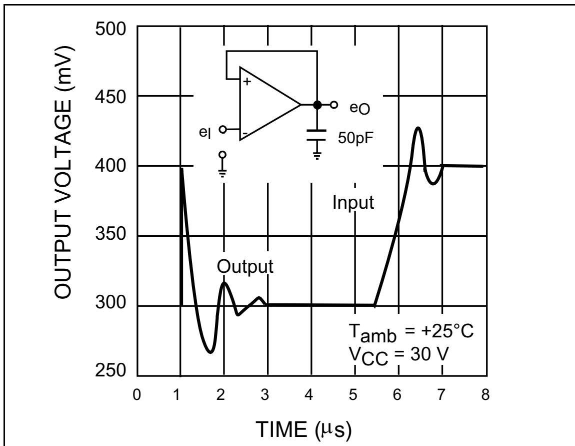


Figure 12. Input voltage range

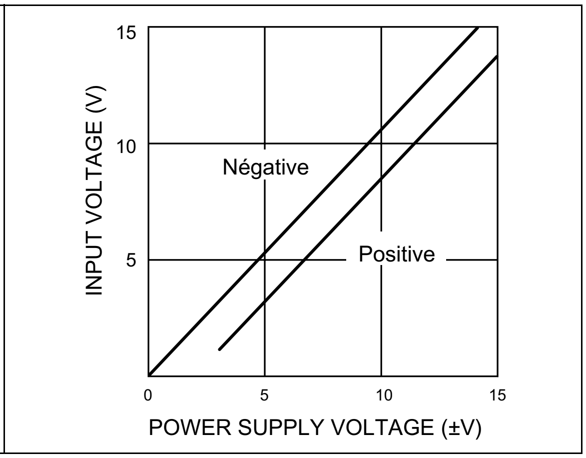


Figure 13. Voltage gain

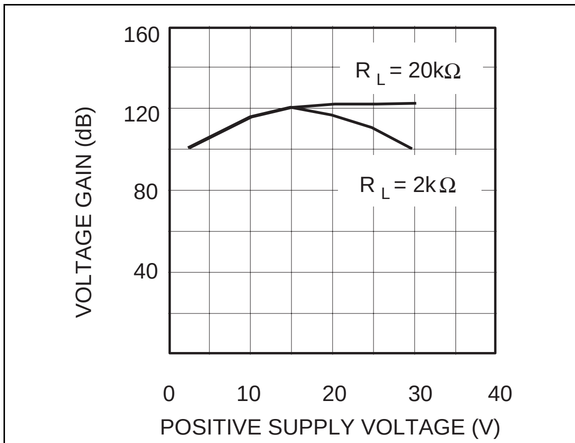


Figure 14. Gain bandwidth product

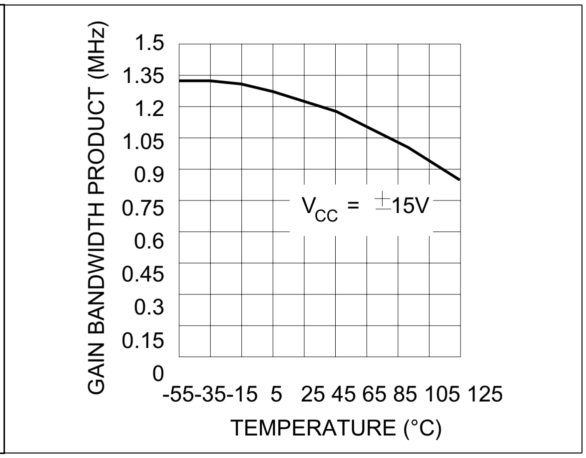


Figure 15. Power supply rejection ratio versus temperature

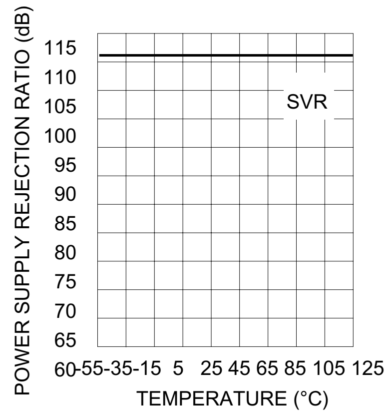
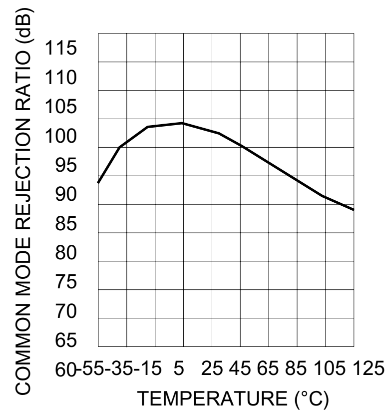


Figure 16. Common mode rejection ratio versus temperature



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 drawing

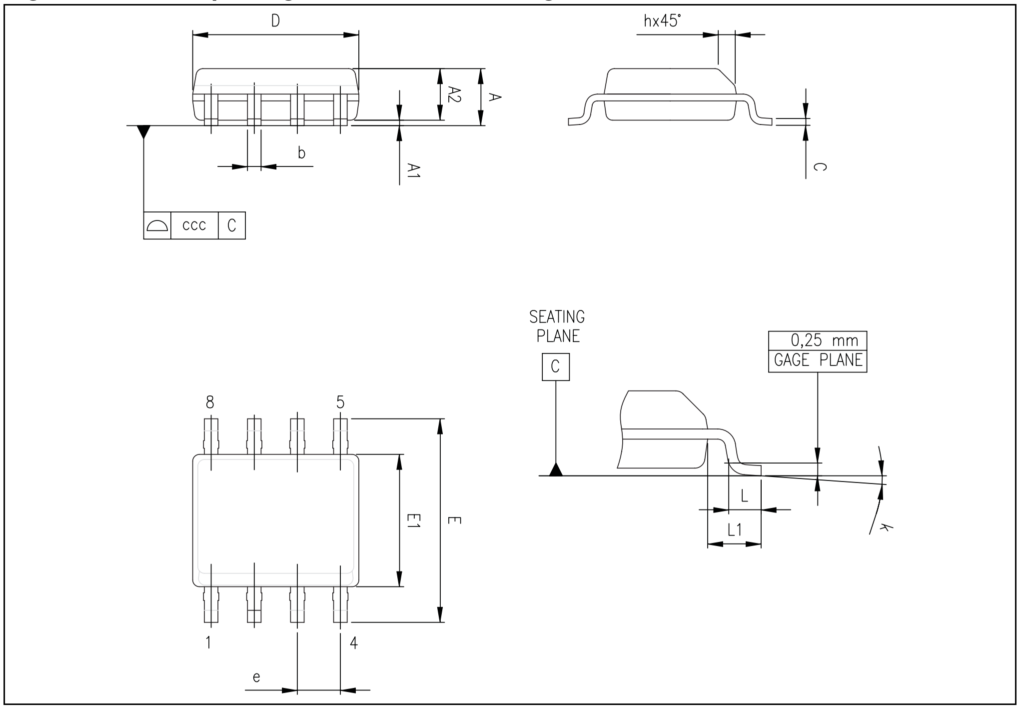


Table 4. SO-8 package mechanical data

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
E	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 5. Order codes

Order code	Temperature range	Package	Packing	Marking
JLM2904WH-CD1	-40°C, +150°C	Wafer		
LM2904WHD LM2904WHDT		SO-8	Tube or Tape & reel	2904WH
LM2904WHYD(1) LM2904WHYDT(1)		SO-8 (Automotive grade)	Tube or Tape & reel	2904WHY

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
01-Sep-2003	1	Initial release.
01-Jul-2005	2	PPAP references inserted in the datasheet, see *Section 5: Ordering information*.
01-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.
07-Apr-2008	6	Added R_{thja} and R_{thjc} parameters in *Table 1: Absolute maximum ratings*. Updated format of package information for SO-8. Corrected marking error in *Table 5: Order codes* (2904WHY, not 2904WY).

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