LM2904WH

Datasheet

Low-power dual operational amplifier

MiniSO8

SO8

Wafer form

Features

- Frequency compensation implemented internally
- 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 (temperature compensated)
- 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 VCC - 1.5 V
- Internal ESD protection: 2 kV HBM, 200 V MM

Description

This circuit consists of two independent, high-gain, operational amplifiers that have frequency compensation implemented internally. The circuit is 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, these circuits can be directly supplied from standard 5 V which is used in logic systems and which easily provides 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 it is operated from a single-power supply.

1 Schematic diagram and pad locations

Figure 1. Schematic diagram (1/2 LM2904WH)

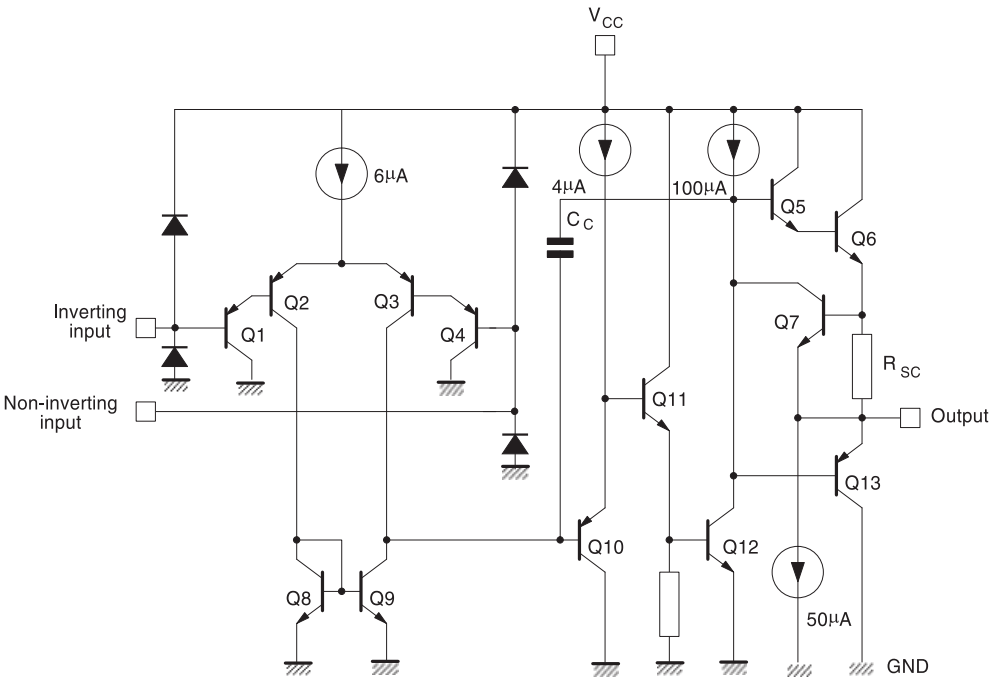
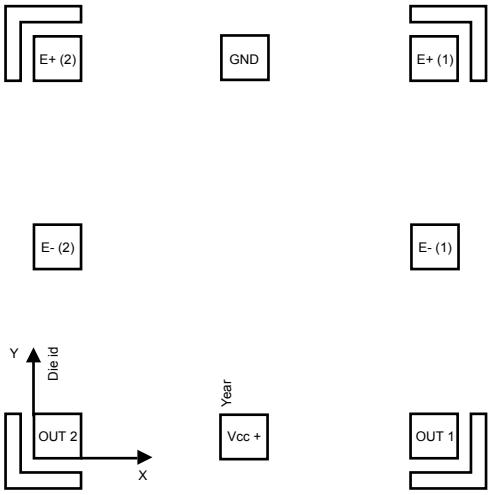


Figure 2. Pad locations



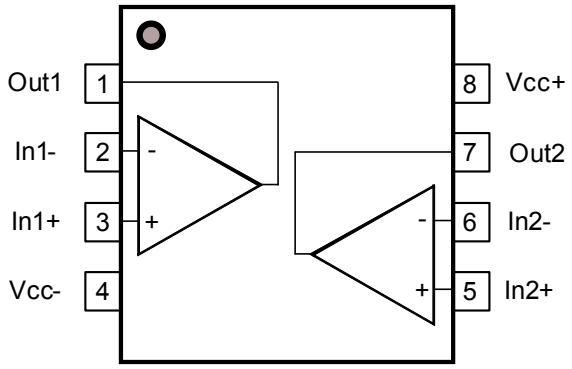
The origin coordinate is at the bottom left part of the OUT2 pin. All dimensions are specified in micrometers (µm).

Table 1. Pad locations

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

2 Package pin connections

Figure 3. **MiniSO8 and SO8 package pin connections (top view)**



3 Absolute maximum ratings and operating conditions

Table 2. Absolute maximum ratings (AMR)

Symbol	Parameter		Value	Unit
V_{CC} +	Supply voltage		32	V
V_{id}	Differential input voltage		-0.3 to VCC + 0.3	
V_{in}	Input voltage		-0.3 to VCC + 0.3	
I_{in}	Input current (1)		5	mA
	Output short-circuit to ground (2)		40	
T_{stg}	Storage temperature range		-65 to 160	°C
T_j	Maximum junction temperature		160	
R_{thja} (3)	Thermal resistance junction to ambient	SO8	125	°C/W
		MiniSO8	190	
R_{thjc} (3)	Thermal resistance junction to case	SO8	40	
		MiniSO8	39	
ESD	HBM: human body model (4)		2	kV
	MM: machine model (5)		200	V
	CDM: charged device model (6)		1.5	kV

1. *This input current only exists when the voltage value 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 -0.3 V.*
2. *Short-circuits from the output to VCC can cause excessive heating if VCC+ is < 15 V. The maximum output current is approximately 40 mA, independent of the magnitude of VCC. Destructive dissipation can result from simultaneous short-circuits on all amplifiers*
3. *Short-circuits can cause excessive heating and destructive dissipation. Values are typical.*
4. *Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ 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 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 < 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 3. Operating conditions

Symbol	Parameter		Value	Unit
VCC+	Supply voltage		3 to 30	V
Vicm	Input common-mode input voltage range (VCC+ = 30 V) (1)	Tamb = 25 °C	0 to (VCC+) - 1.5	
		Tmin ≤ Tamb ≤ Tmax	0 to (VCC+) - 2	
Toper	Operating free-air temperature range		-40 to 150	°C

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 (VCC+) – 1.5 V, but either or both inputs can go to 32 V without damage.*

4 Electrical characteristics

Table 4. VCC+ = 5 V, VCC- = ground, VO = 1.4 V, Tamb = 25 ° C (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage (1)			2	7	mV
		Tmin ≤ Tamb ≤ Tmax			9	
I_{io}	Input offset current			2	30	nA
		Tmin ≤ Tamb ≤ Tmax			40	
I_{ib}	Input bias current (2)			20	150	
		Tmin ≤ Tamb ≤ Tmax			200	
A_{vd}	Large signal voltage gain	VCC+ = 15 V, RL = 2 kΩ, VO = 1.4 V to 11.4 V	50	100		V/mV
		Tmin ≤ Tamb ≤ Tmax	2.5			
SVR	Supply voltage rejection ratio	VCC+ = 5 to 30 V, RS ≤ 10 kΩ	65	100		dB
		Tmin ≤ Tamb ≤ Tmax	65			
ICC	Supply current, all amps, no load	VCC+ = 5 V		0.7	1.2	mA
		Tmin ≤ Tamb ≤ Tmax, VCC = 30 V			2	
CMRR	Common-mode rejection ratio	RS = 10 kΩ	70	85		dB
		RS = 10 kΩ, Tmin ≤ Tamb ≤ Tmax	60			
Isource	Output short-circuit current	VCC+ = 15 V, VO = 2 V, VID = 1 V	20	40	60	mA
		Tmin ≤ Tamb ≤ Tmax	10			
Isink	Output sink current	VO = 2 V, VCC+ = 5 V	10	20		
		VO = 2 V, VCC+ = 5 V, Tmin ≤ Tamb ≤ Tmax	5			
		VO = 0.2 V, VCC+ = 15 V	12	50		µA
		VO = 0.2 V, VCC+ = 15 V, Tmin ≤ Tamb ≤ Tmax	10			
VOPP	Output voltage swing	RL = 2 kΩ	0		(VCC+) - 1.5	V
		RL = 2 kΩ, T_{min} ≤ Tamb ≤ Tmax	0		(VCC+) - 2	
V_{OH}	High level output voltage	VCC+ = 30 V, RL = 2 kΩ	26	27		
		VCC+ = 30 V, RL = 2 kΩ, Tmin ≤ Tamb ≤ Tmax	26			
		VCC+ = 30 V, RL = 10 kΩ	27	28		
		VCC+ = 30 V, RL = 10 kΩ, Tmin ≤ Tamb ≤ Tmax	27			
V_{OL}	Low level output voltage	RL = 10 kΩ		5	20	mV
		RL = 10 kΩ. Tmin ≤ Tamb ≤ Tmax			20	
SR	Slew rate (unity gain)	VCC+ = 15 V, Vi = 0.5 to 3 V, RL = 2 kΩ, CL = 100 pF	0.3	0.6		V/µs
		Tmin ≤ Tamb ≤ Tmax	0.2			
GBP	Gain bandwidth product	f = 100 kHz, VCC+ = 30 V, Vin = 10 mV, RL = 2 kΩ, CL = 100 pF	0.7	1.1		MHz

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
GBP	Gain bandwidth product	f = 100 kHz, Tmin ≤ Tamb ≤ Tmax	0.45			MHz
THD	Total harmonic distortion	f =1 kHz, Av = 20 dB, RL = 2 kΩ, VO = 2 Vpp, CL = 100 pF, VCC = 30 V		0.02		%
e_n	Equivalent input noise voltage	f = 1 kHz, RS = 100 Ω, VCC = 30 V		55		nV / √Hz
DVio	Input offset voltage drift			7	30	µV/°C
DIio	Input offset current drift			10	300	pA/°C
VO1/VO2	Channel separation (3)	1 kHz ≤ f ≤ 20 kHz		120		dB

1. *VO = 1.4 V, RS = 0 Ω, 5 V < VCC+ < 30 V, 0 V < Vic < (VCC+) - 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 4. Open loop frequency response

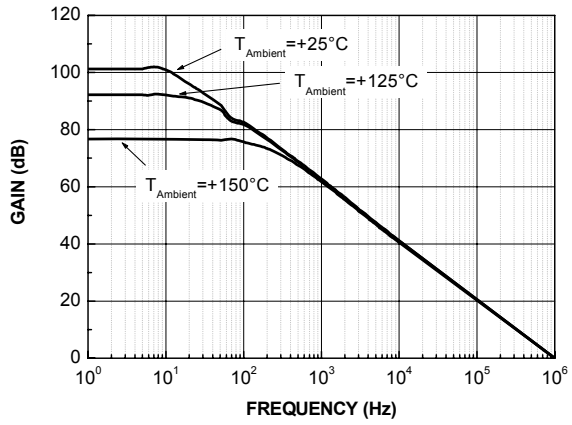


Figure 5. Large signal frequency response

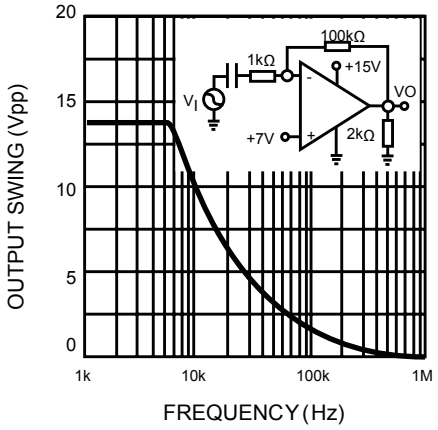


Figure 6. Voltage follower pulse response

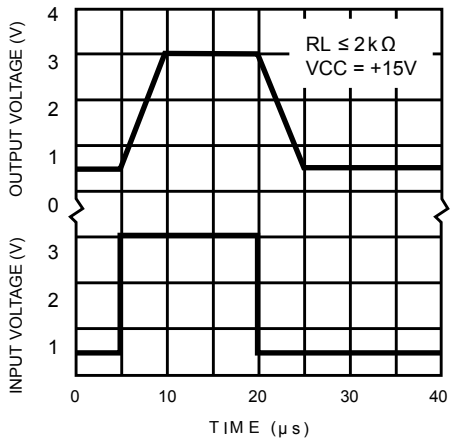


Figure 7. Input bias current

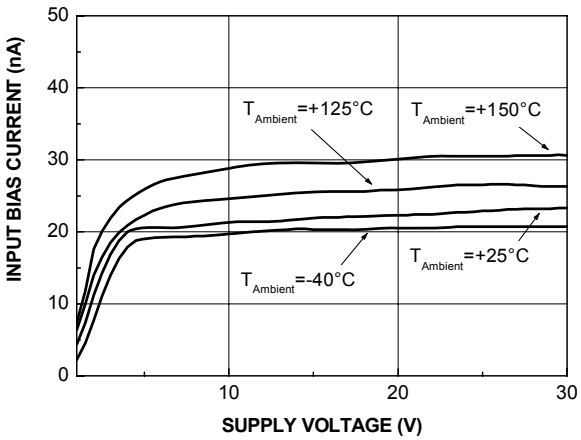


Figure 8. Supply current

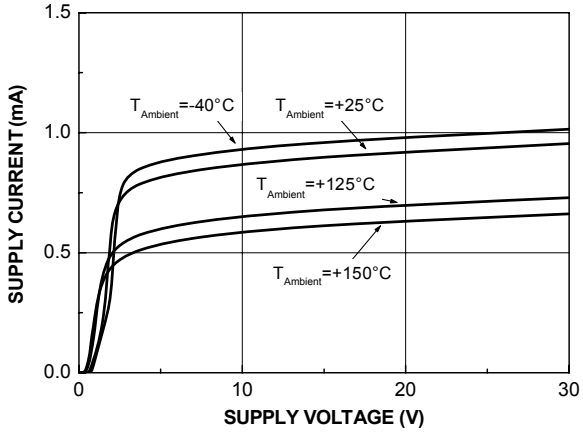


Figure 9. Output characteristics

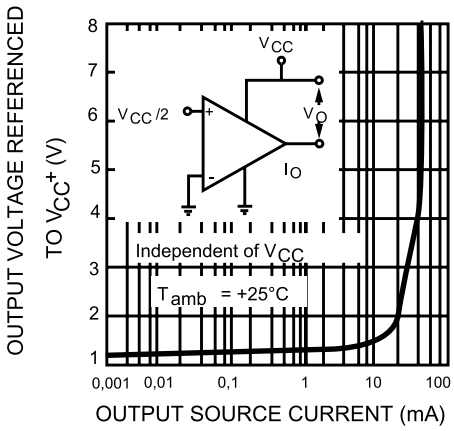


Figure 10. Output characteristics (sink)

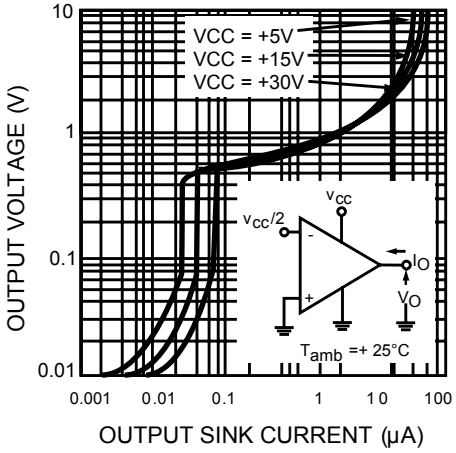


Figure 11. Current limiting

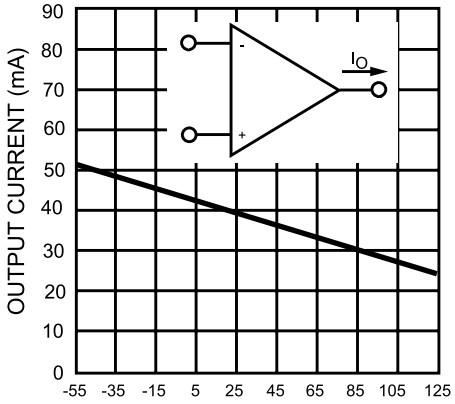


Figure 12. Voltage follower pulse response

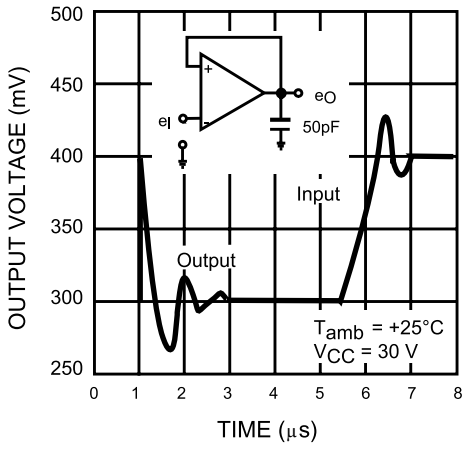


Figure 13. Input voltage range

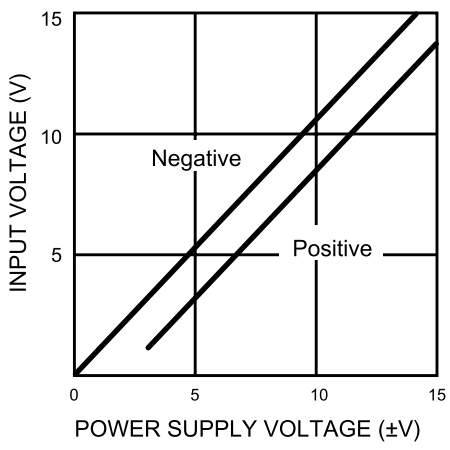


Figure 14. Voltage gain

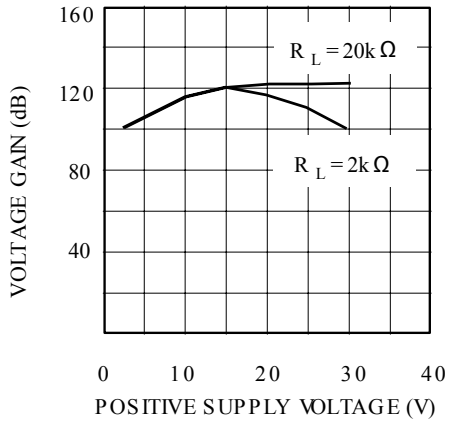


Figure 15. Gain bandwidth product

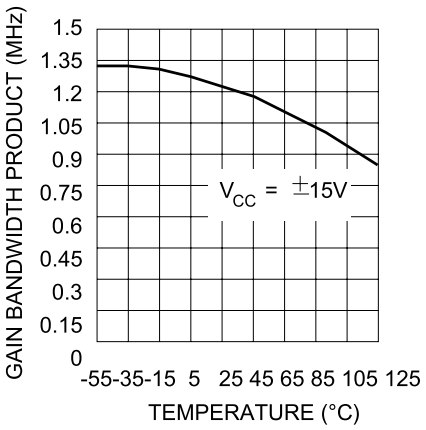


Figure 16. Power supply rejection ratio versus temperature

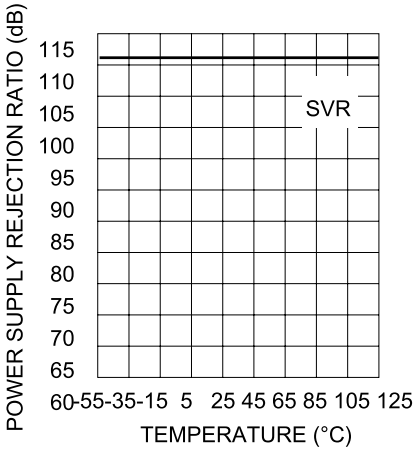
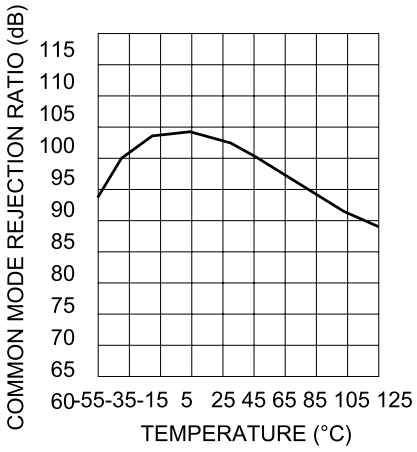


Figure 17. Common mode rejection ratio versus temperature



5 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.

5.1 MiniSO8 package information

Figure 18. MiniSO8 package outline

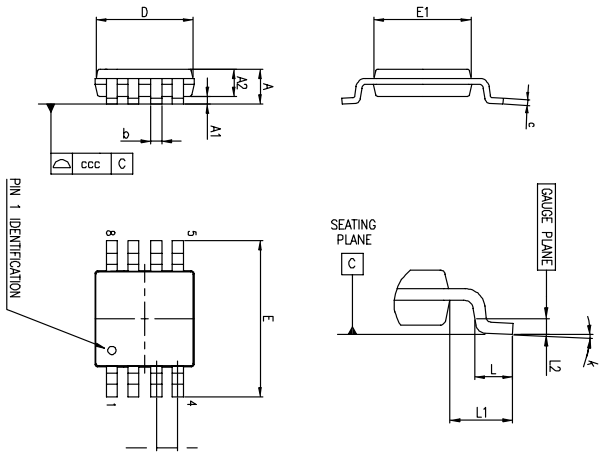


Table 5. MiniSO8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.1			0.043
A1	0		0.15	0		0.0006
A2	0.75	0.85	0.95	0.030	0.033	0.037
b	0.22		0.40	0.009		0.016
c	0.08		0.23	0.003		0.009
D	2.80	3.00	3.20	0.11	0.118	0.126
E	4.65	4.90	5.15	0.183	0.193	0.203
E1	2.80	3.00	3.10	0.11	0.118	0.122
e		0.65			0.026	
L	0.40	0.60	0.80	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.010	
k	0°		8°	0°		8°
ccc			0.10			0.004

5.2 SO8 package information

Figure 19. **SO8 package outline**

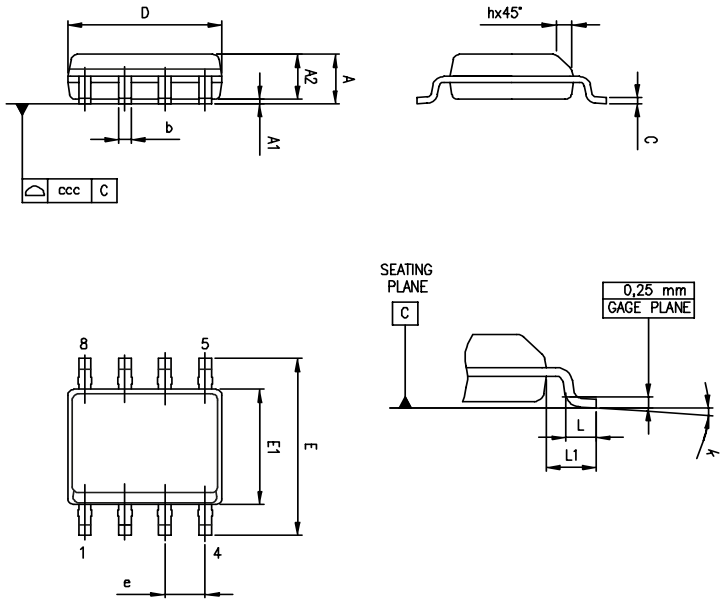


Table 6. **SO8 package mechanical data**

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
L1		1.04			0.040	
k	0°		8°	0°		8°
ccc			0.10			0.004

6 Ordering information

Table 7. Order codes

Order code	Temperature range	Package	Packaging	Marking
JLM2904WH-CD1	-40 to 150 °C	Wafer	—	—
LM2904WHDT		SO8	Tube or tape and reel	2904WH
LM2904WHYDT (1)		SO8 (automotive grade)		2904WHY
LM2904WHYST (2)		MiniSO8	Tape and reel	K422

1. *Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent.*
2. *Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q 002 or equivalent are on-going.*

Revision history

Table 8. **Document revision history**

Date	Revision	Changes
01-Sep-2003	1	Initial release
01-Jul-2005	2	PPAP references inserted in the datasheet, see Section 6 Ordering information
01-Oct-2005	3	Correction of error in AVD min. value in Table 4. VCC+ = 5 V, VCC- = ground, VO = 1.4 V, Tamb = 25 ° C (unless otherwise specified). Minor grammatical and formatting changes throughout.
27-Sep-2006	4	Correction of error in AVD min. value in Table 4. VCC+ = 5 V, VCC- = ground, VO = 1.4 V, Tamb = 25 ° C (unless otherwise specified).
20-Jul-2007	5	ESD values added in Table 2. Absolute maximum ratings (AMR). Equivalent input noise parameter added in Table 4. VCC+ = 5 V, VCC- = ground, VO = 1.4 V, Tamb = 25 ° C (unless otherwise specified). Electrical characteristics curves updated. Package information updated.
07-Apr-2008	6	Added Rthja and Rthjc parameters in Table 2. Absolute maximum ratings (AMR). Updated format of package information for SO-8. Corrected marking error in Table 7. Order codes (2904WHY, not 2904WY).
04-Jul-2012	7	Removed commercial type LM2904WHYD. Updated Table 7. Order codes.
01-Apr-2015	8	Added MiniSO8 silhouette and package. Table 2. Absolute maximum ratings (AMR): added MiniSO8 information for the parameters Rthja and Rthjc and updated the parameters Tstg and Tj. Section 5.2 : added "L1" dimension. Table 7. Order codes: added order code LM2904WHYST and removed obsolete order code LM2904WHD.
24-Aug-2020	9	Added Section 2 Package pin connections.