



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 in pin to pin mode
 - 200V MM

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 off the 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 only a single power supply voltage.

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1 Schematic diagram

Figure 1. Schematic diagram (1/2 LM2904WH)

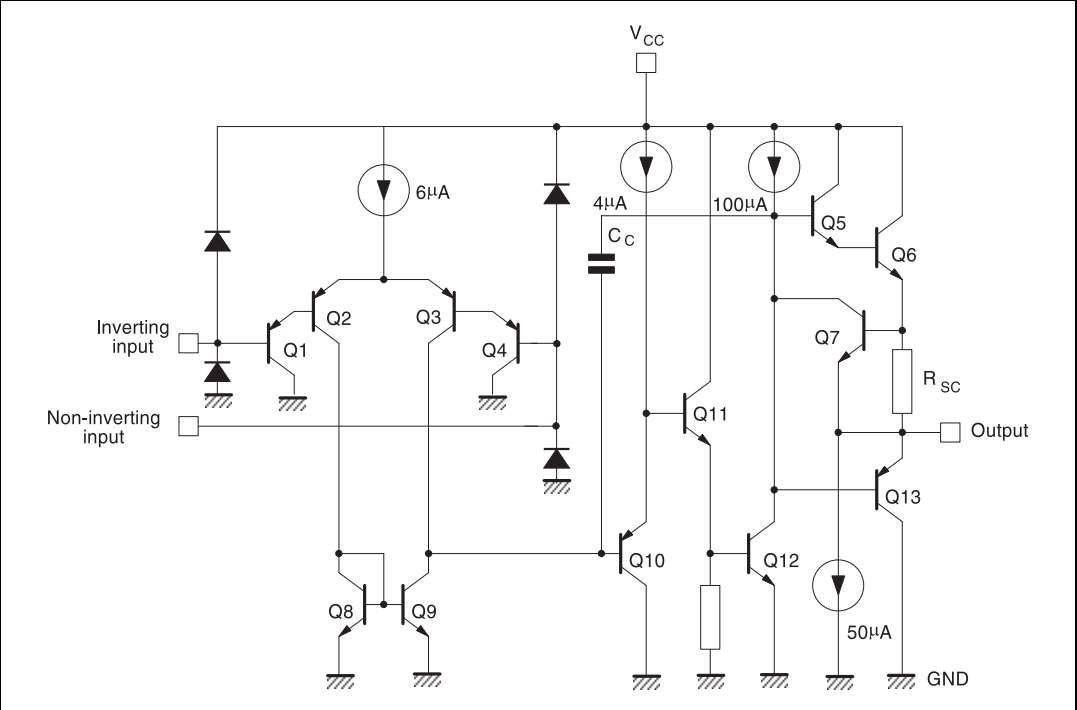
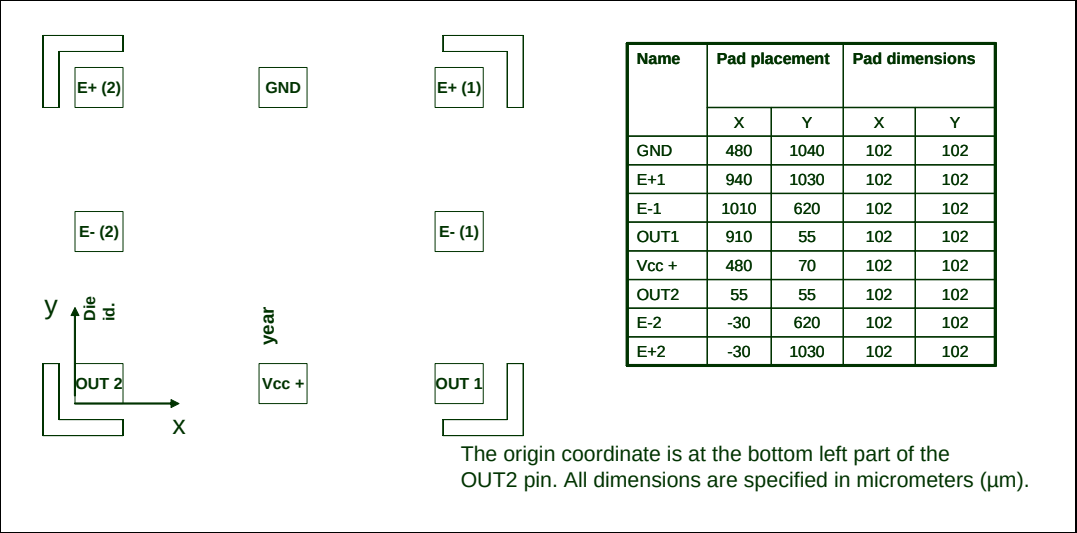


Figure 2. Pad locations



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 $T_{amb}=+25^{\circ}\text{C}$ ⁽²⁾	710	mW
I_{in}	Input current ⁽³⁾	5	mA
T_{stg}	Storage temperature range	-65 to +150	$^{\circ}\text{C}$

1. Short-circuits from the output to V_{CC} can cause excessive heating if $V_{CC}^+ > 15\text{V}$. 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 $T_{amb} = +25^{\circ}\text{C}$, $T_{junction} = +150^{\circ}\text{C}$ and $R_{thja} = 175^{\circ}\text{C/W}$ 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.

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	$^{\circ}\text{C}$

3 Electrical characteristics

Table 3. $V_{CC}^+ = 5V$, $V_{CC}^- = \text{Ground}$, $V_O = 1.4V$, $T_{\text{amb}} = 25^\circ\text{C}$ (unless otherwise specified)

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

Table 3. $V_{CC}^+ = 5V$, $V_{CC}^- = \text{Ground}$, $V_O = 1.4V$, $T_{amb} = 25^\circ C$ (unless otherwise specified) (continued)

Symbol	Parameter	Min.	Typ.	Max.	Unit
SR	Slew rate (unity gain) $V_{CC}^+ = 15V$, $V_i = 0.5$ to $3V$, $R_L = 2k\Omega$, $C_L = 100pF$, $T_{min} \leq T_{amb} \leq T_{max}$	0.3 0.2	0.6		V/ μs
GBP	Gain bandwidth product $f = 100kHz$ $V_{CC}^+ = 30V$, $V_{in} = 10mV$, $R_L = 2k\Omega$, $C_L = 100pF$ $T_{min} \leq T_{amb} \leq T_{max}$	0.7 0.45	1.1		MHz
THD	Total harmonic distortion $f = 1kHz$, $A_V = 20dB$, $R_L = 2k\Omega$, $V_O = 2V_{pp}$, $C_L = 100pF$, $V_{CC} = 30V$		0.02		%
DV_{iO}	Input offset voltage drift		7	30	$\mu V/^\circ C$
DI_{iO}	Input offset current drift		10	300	$pA/^\circ C$
V_{O1}/V_{O2}	Channel separation ⁽⁴⁾ $1kHz \leq f \leq 20kHz$		120		dB

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

Figure 3. Open loop frequency response

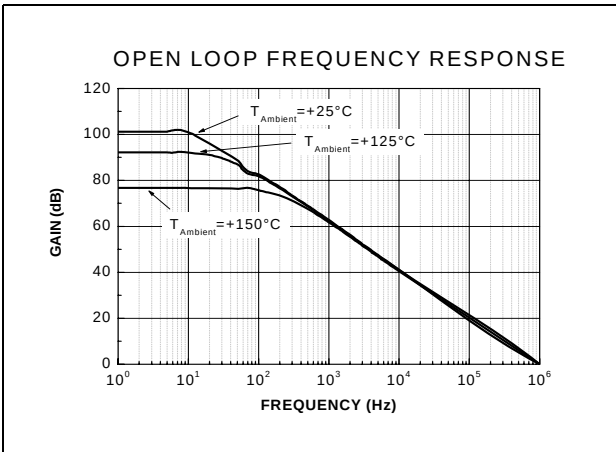


Figure 4. Large signal frequency response

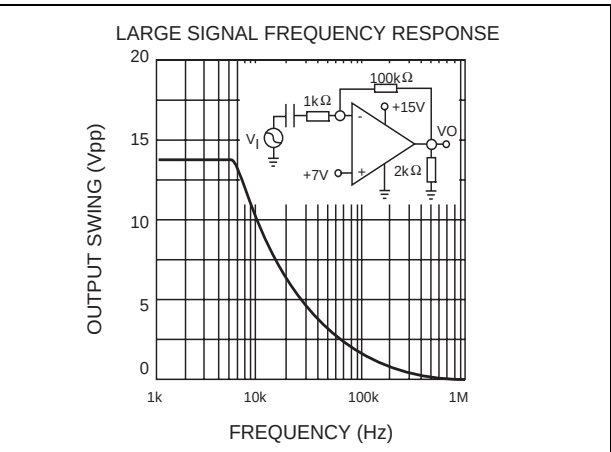


Figure 5. Voltage follower pulse response

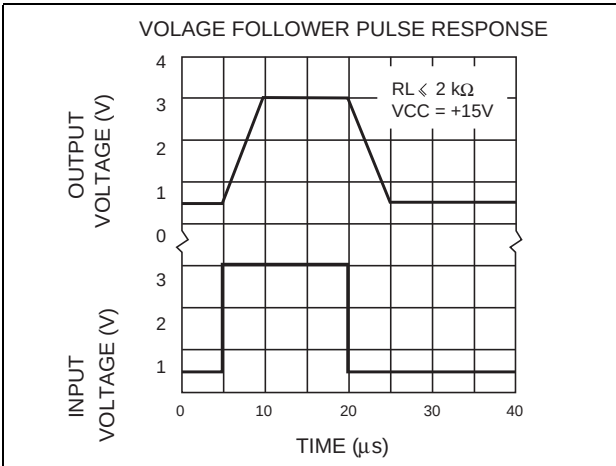


Figure 6. Supply voltage

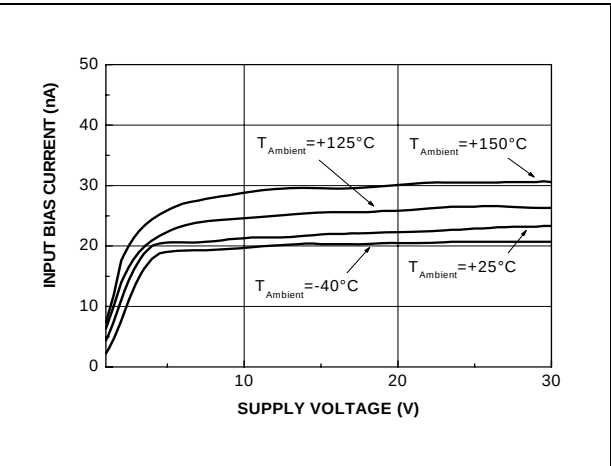


Figure 7. Output characteristics

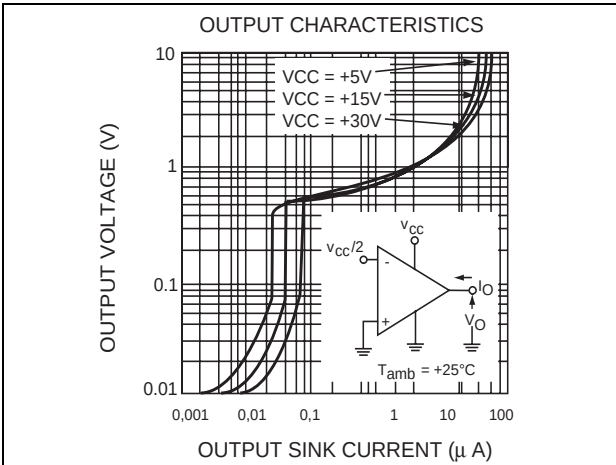


Figure 8. Current limiting

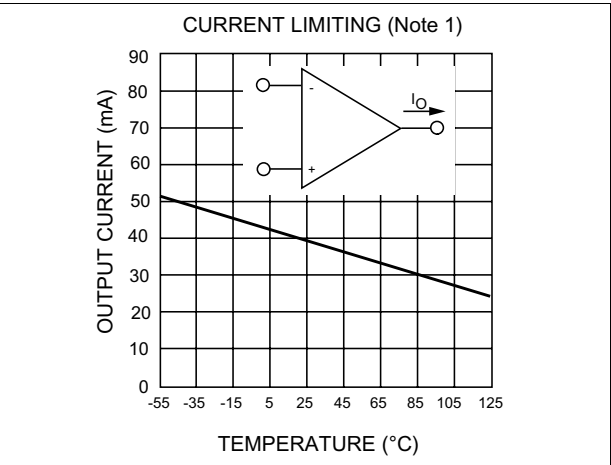


Figure 9. Voltage follower pulse response

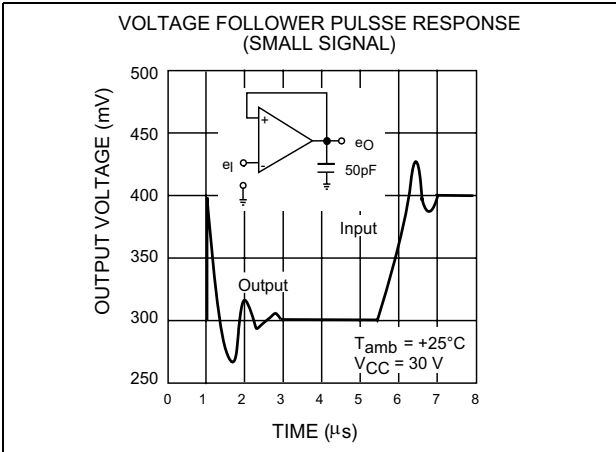


Figure 10. Input voltage range

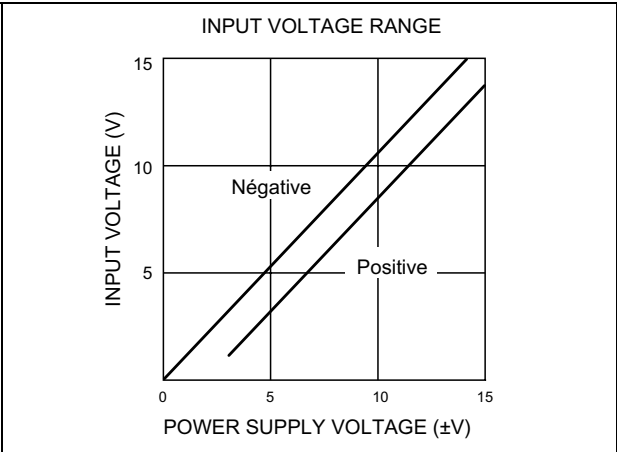


Figure 11. Output characteristics

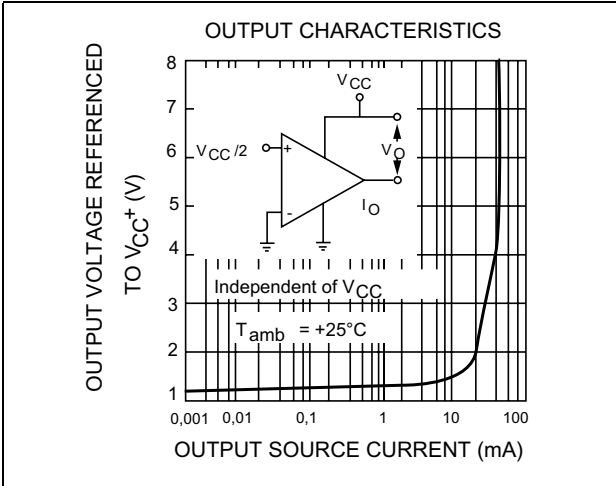


Figure 12. Supply voltage

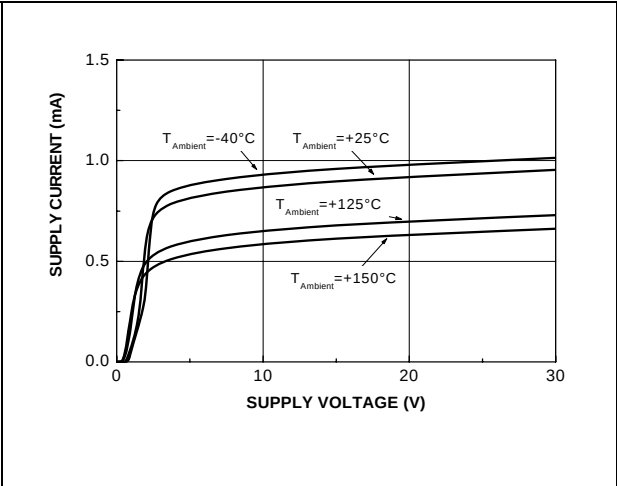


Figure 13. Positive supply voltage

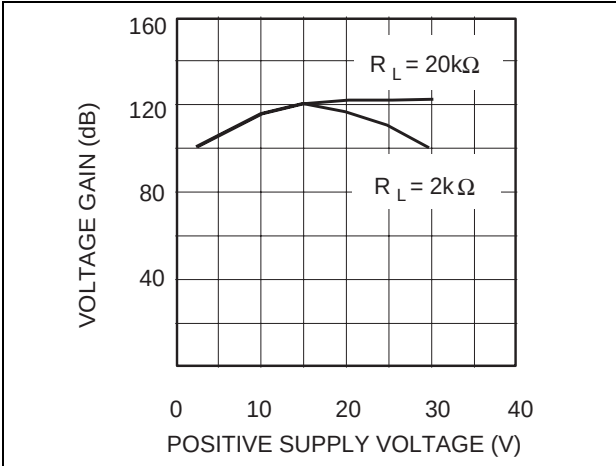


Figure 14. Gain bandwidth product

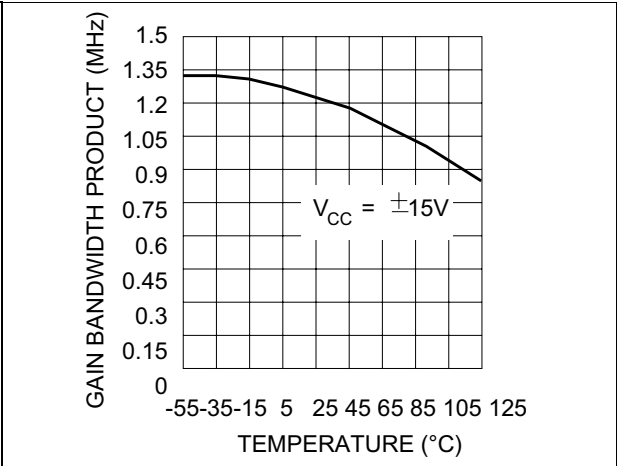


Figure 15. Positive supply voltage

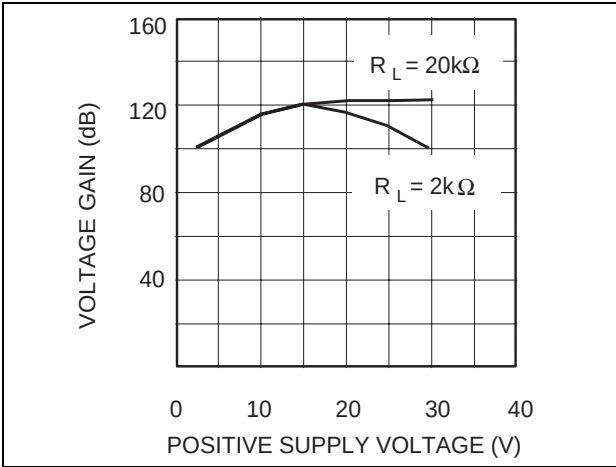


Figure 16. Gain bandwidth product

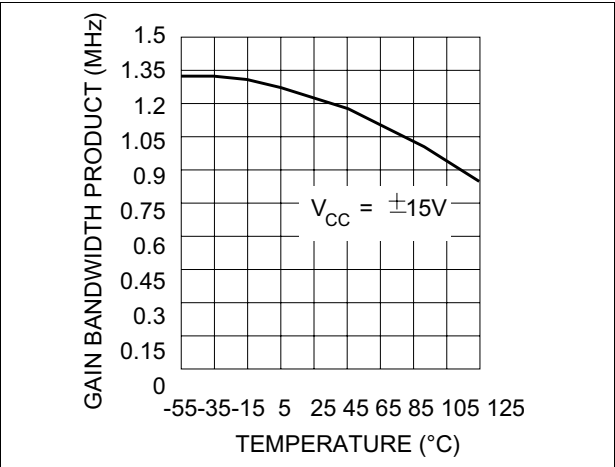


Figure 17. Positive supply voltage

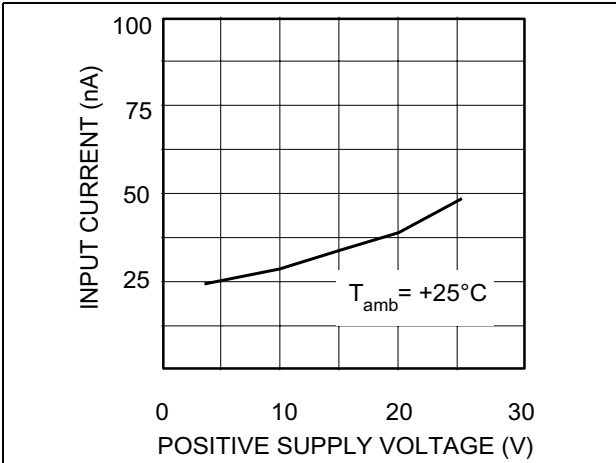


Figure 18. Power supply rejection ratio

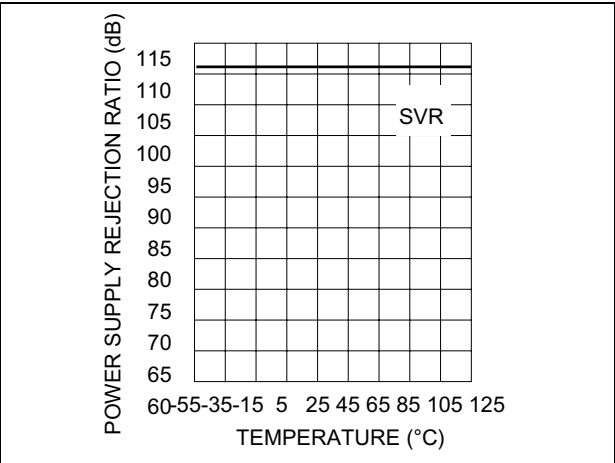


Figure 19. Positive supply voltage

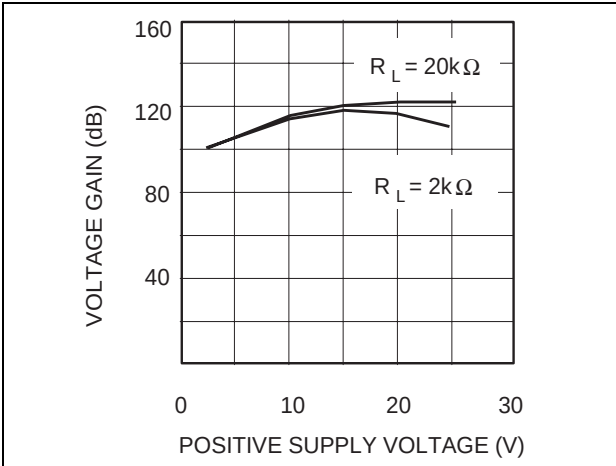
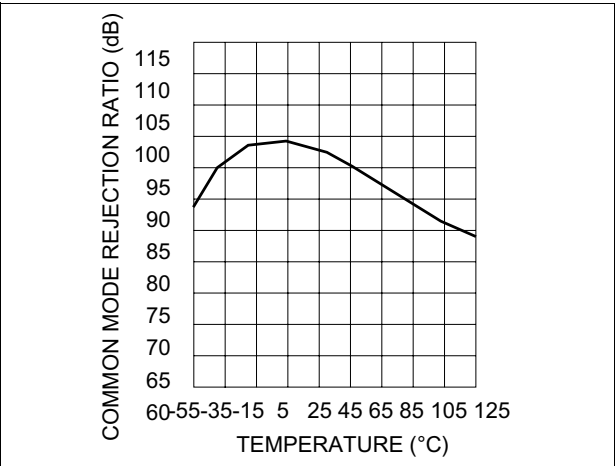


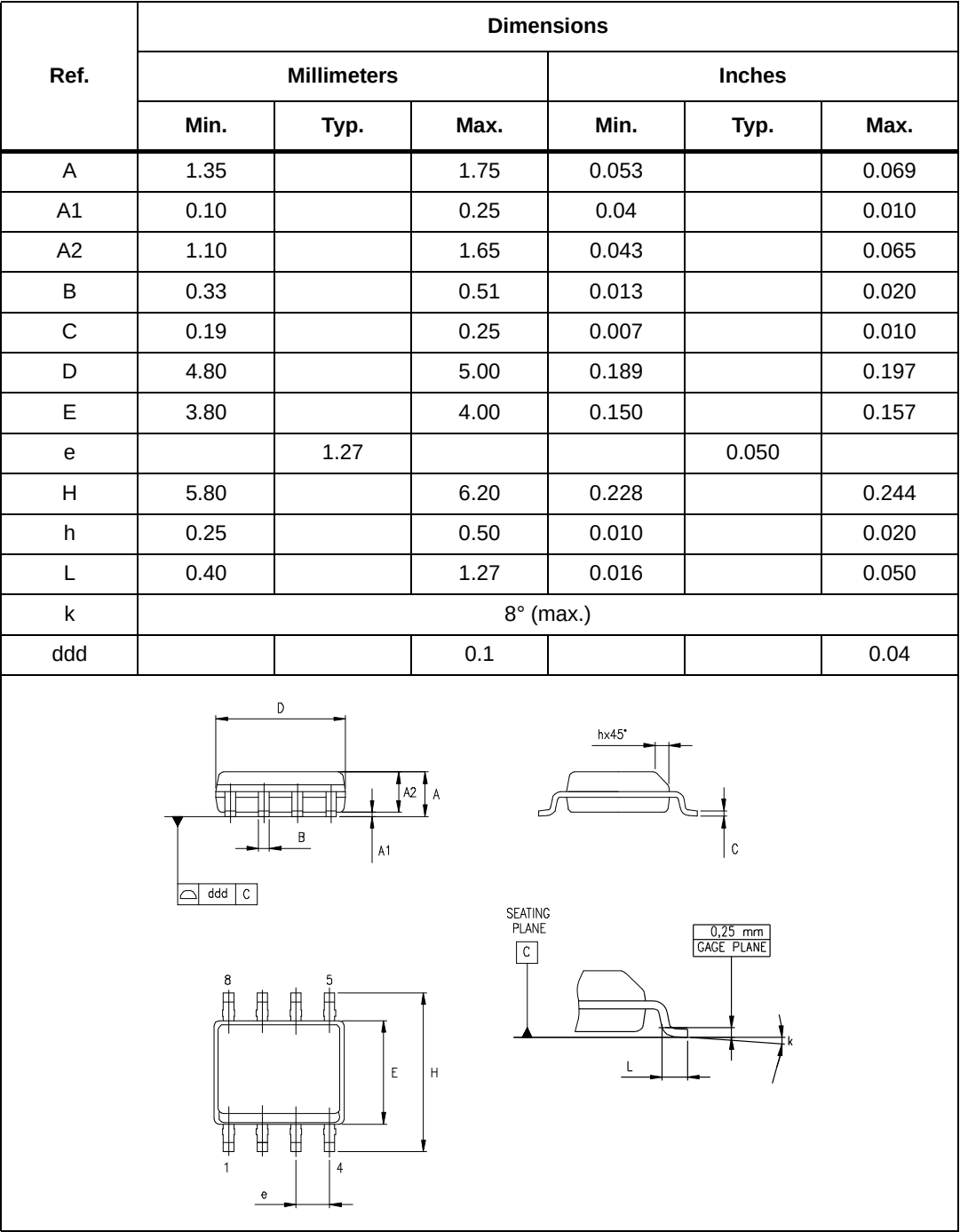
Figure 20. Common mode rejection ratio



4 **Package mechanical data**

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 21. SO-8 package



5 Ordering information

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

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	The following changes were made in this revision: – 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 .

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