



## LOW POWER DUAL OPERATIONAL AMPLIFIERS

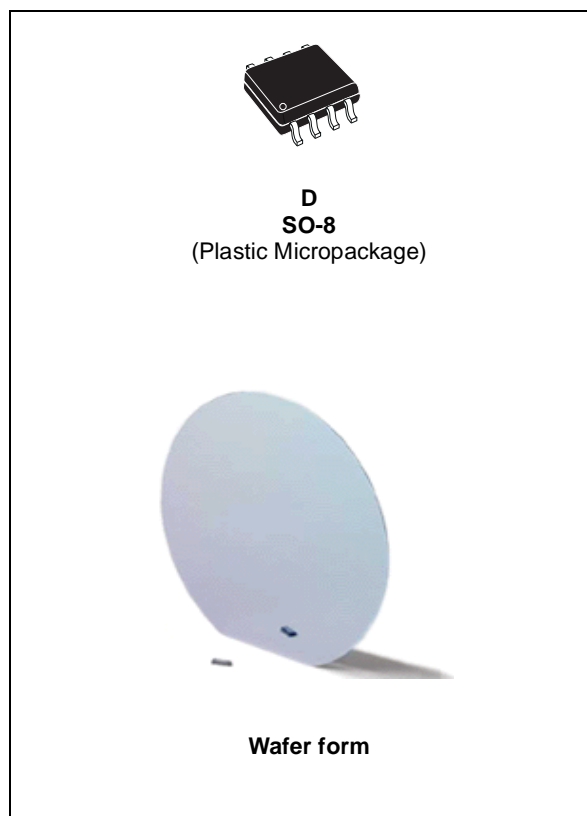
- INTERNALLY FREQUENCY COMPENSATED
- LARGE DC VOLTAGE GAIN: 100dB
- WIDE BANDWIDTH (unity gain: 1.1MHz (temperature compensated))
- VERY LOW SUPPLY CURRENT/OP (500µA)
- LOW INPUT BIAS CURRENT: 20nA (temperature compensated)
- LOW INPUT OFFSET CURRENT: 2nA
- INPUT COMMON-MODE VOLTAGE RANGE INCLUDES GROUND
- DIFFERENTIAL INPUT VOLTAGE RANGE EQUAL TO THE POWER SUPPLY VOLTAGE
- LARGE OUTPUT VOLTAGE SWING 0V TO ( $V_{CC} - 1.5V$ )
- INTERNAL ESD PROTECTION:  
1500V HBM in pin to pin mode  
200V MM

### DESCRIPTION

This circuit consists of two independent, high gain, internally frequency compensated which were designed specifically for automotive and industrial control system. 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 with 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 the 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.



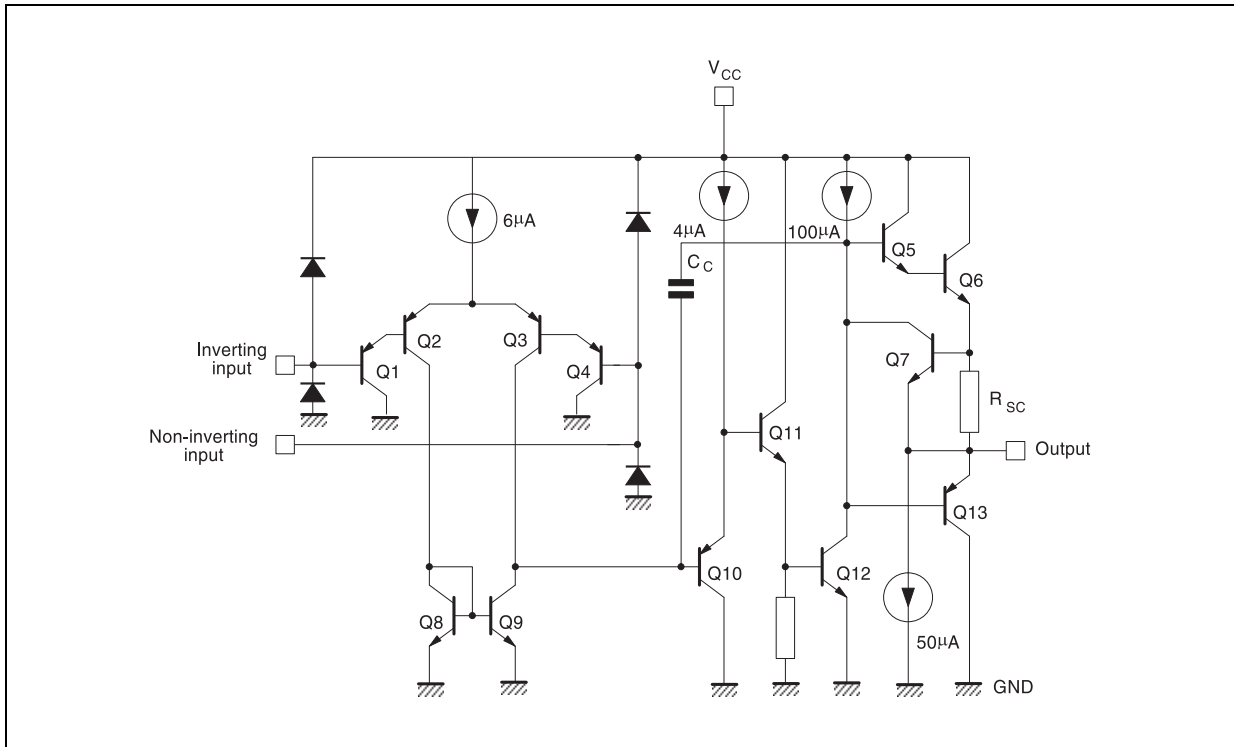
### ORDER CODE

Part Number	Temperature Range	Package	
		Wafer	SO
JLM2904WH-CD1	-40°C, +150°C	•	
LM2904WHD	-40°C, +150°C		•

D = Small outline package (SO) - Also available in Tape & Reel (DT)

# LM2904WH

## SCHEMATIC DIAGRAM (1/2 LM2904WH)



## PAD LOCATIONS

The die pad locations diagram shows the layout of pads for the LM2904WH (1/2) die. The pads are labeled as follows: GND, E+ (1), E+ (2), E- (1), E- (2), Vcc +, OUT1, and OUT2. A coordinate system is provided with the origin at the center of the die. The X-axis is horizontal and the Y-axis is vertical. The die is oriented with the 'year' label at the top and the 'Die id.' label on the left.

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

## 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 <sup>1)</sup>	40	mA
$P_D$	Power Dissipation at $T_{AMB}=+25^{\circ}C$ <sup>2)</sup>	710	mW
$I_{in}$	Input Current <sup>3)</sup>	5	mA
$T_{stg}$	Storage Temperature Range	-65 to +150	$^{\circ}C$

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  $T_{AMB}=+25^{\circ}C$ ,  $T_{Junction}=+150^{\circ}C$  and  $R_{TH J-A}=175^{\circ}C/W$  for SO8 package

3. This input current only exists when the voltage values applied on the inputs is beyond the supply voltage lines limits. This is not destructive if the current is limited to 5mA as mentioned and normal output will set up again for input voltage higher than -0.3V

## OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
$V_{CC}^{+}$	Supply Voltage	3 to 30	V
$T_{oper}$	Operating Free-Air Temperature Range	-40 to +150	$^{\circ}C$

## ELECTRICAL CHARACTERISTICS

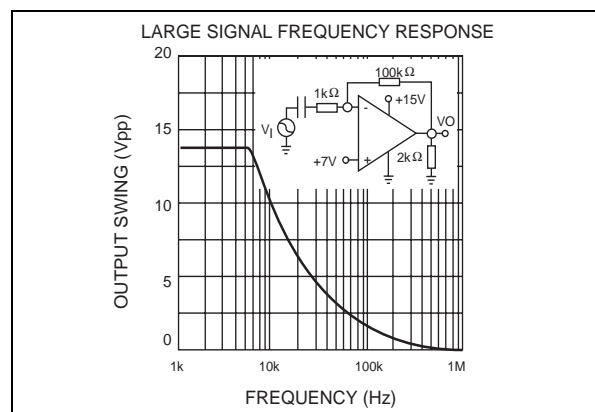
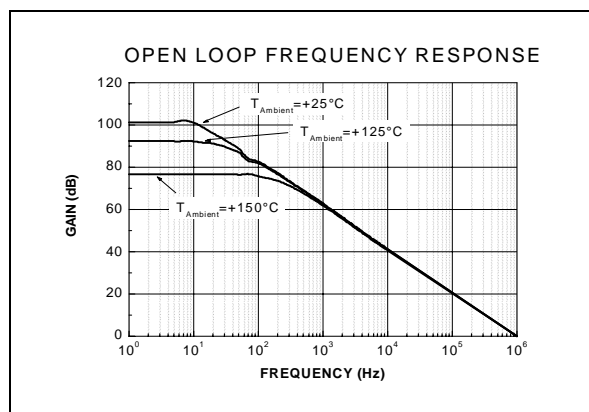
$V_{CC}^{+} = 5V$ ,  $V_{CC}^{-} = \text{Ground}$ ,  $V_O = 1.4V$ ,  $T_{amb} = 25^{\circ}C$  (unless otherwise specified)

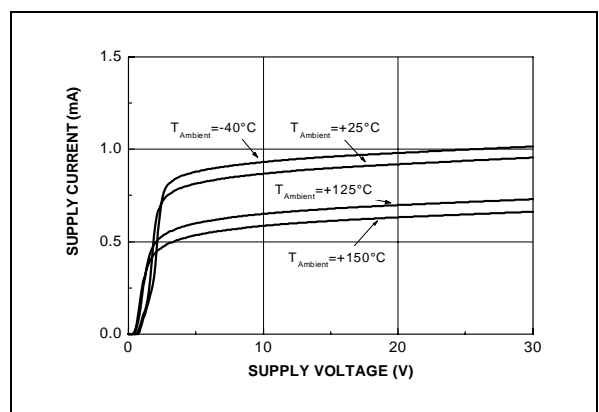
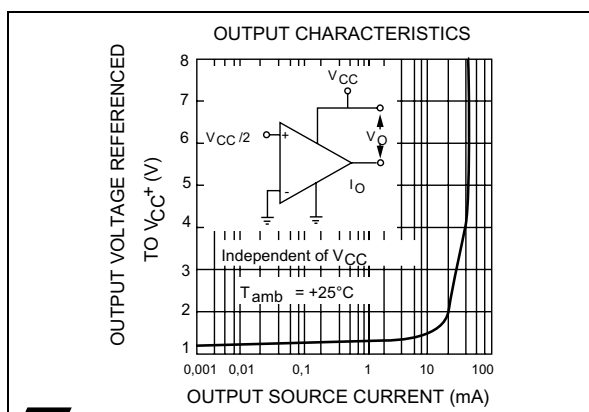
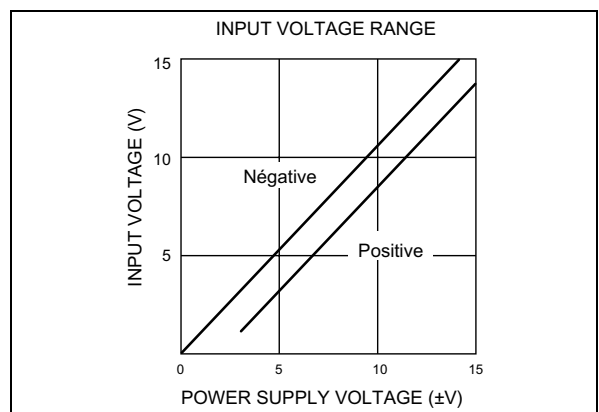
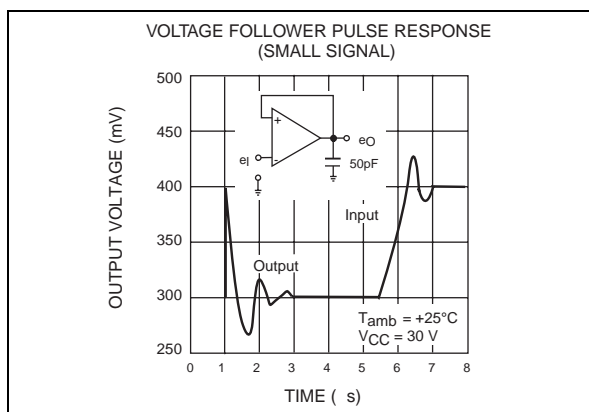
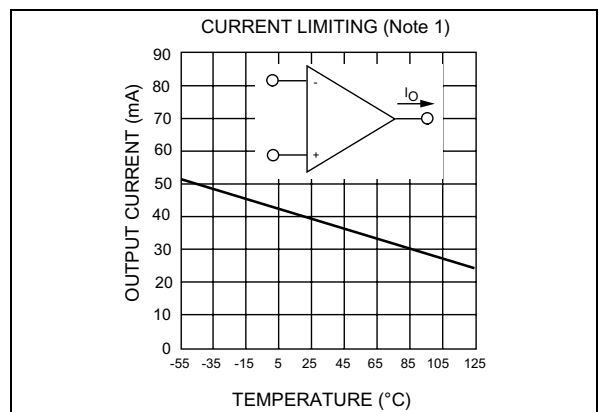
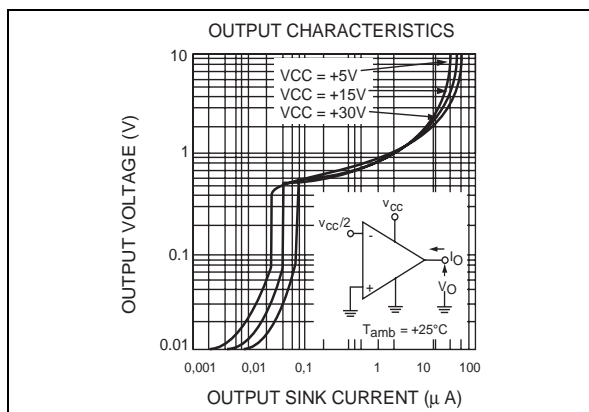
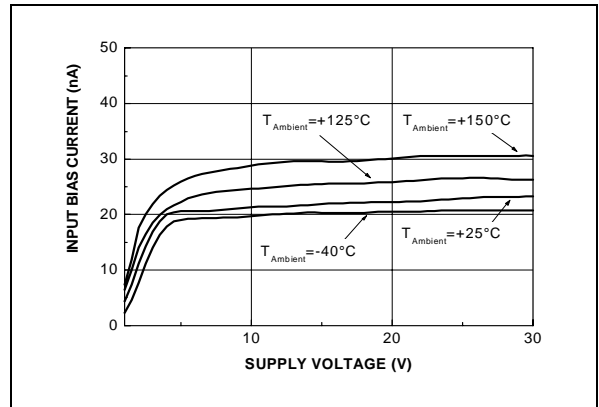
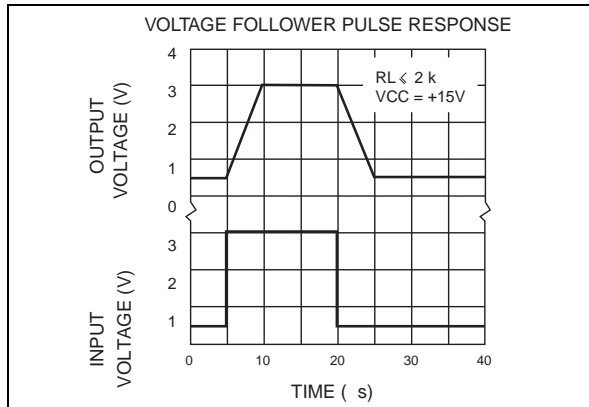
Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input Offset Voltage <sup>1)</sup> $T_{min} \leq T_{amb} \leq T_{max}$ .		2	7 9	mV
$I_{io}$	Input Offset Current $T_{min} \leq T_{amb} \leq T_{max}$ .		2	30 40	nA
$I_{ib}$	Input Bias Current <sup>2)</sup> $T_{min} \leq T_{amb} \leq T_{max}$ .		20	150 200	nA
$A_{vd}$	Large Signal Voltage Gain $V_{CC}^{+} = +15V, R_L = 2k\Omega, V_O = 1.4V$ to 11.4V $T_{min} \leq T_{amb} \leq T_{max}$ .	50 2.5	100		V/mV
SVR	Supply Voltage Rejection Ratio $V_{CC}^{+} = +5$ to +30V, $R_S \leq 10k\Omega$ $T_{min} \leq T_{amb} \leq T_{max}$ .	65 65	100		dB
$I_{cc}$	Supply Current, all Amp, no load $T_{amb} = 25^{\circ}C$ $V_{CC} = +5V$ $T_{min} \leq T_{amb} \leq T_{max}$ . $V_{CC} = +30V$		0.7	1.2 2	mA
$V_{icm}$	Input Common Mode Voltage Range ( $V_{CC} = +30V$ ) <sup>3)</sup> $T_{min} \leq T_{amb} \leq T_{max}$ .	0 0		$V_{CC}^{+} - 1.5$ $V_{CC}^{+} - 2$	V
CMR	Common-mode Rejection Ratio ( $R_S = 10k\Omega$ ) $T_{min} \leq T_{amb} \leq T_{max}$ .	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

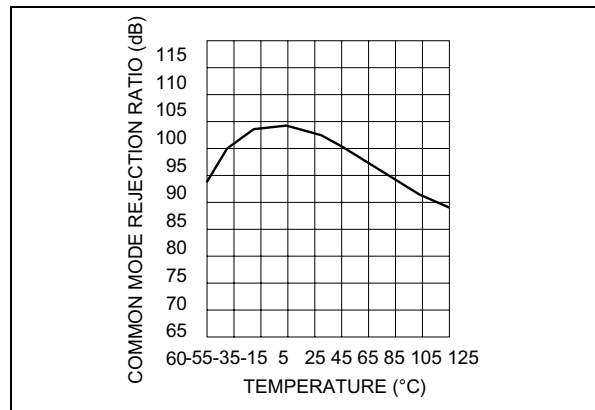
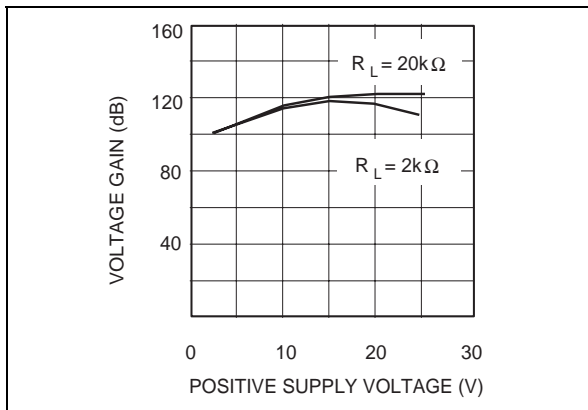
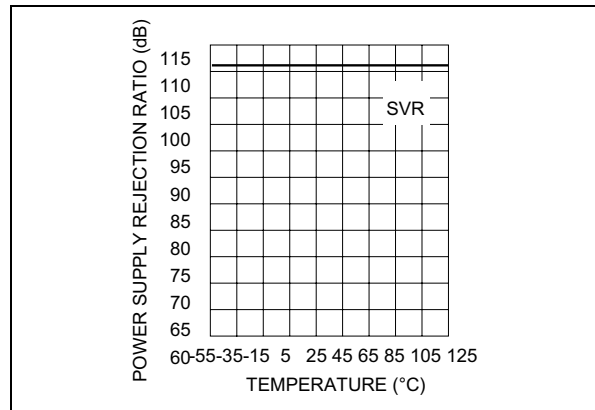
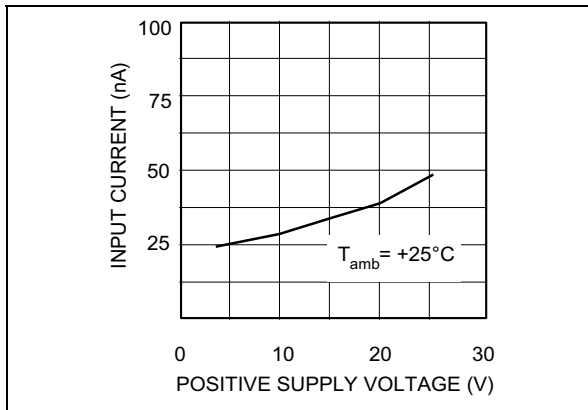
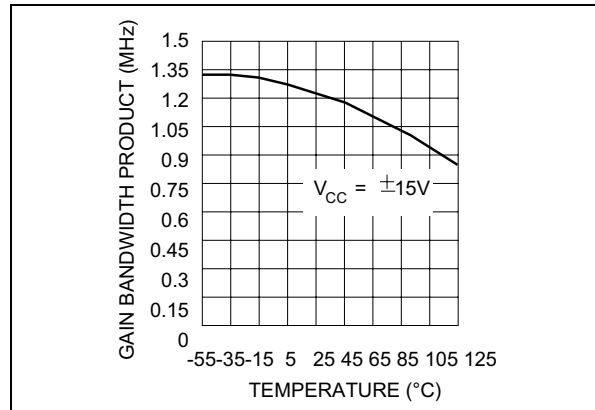
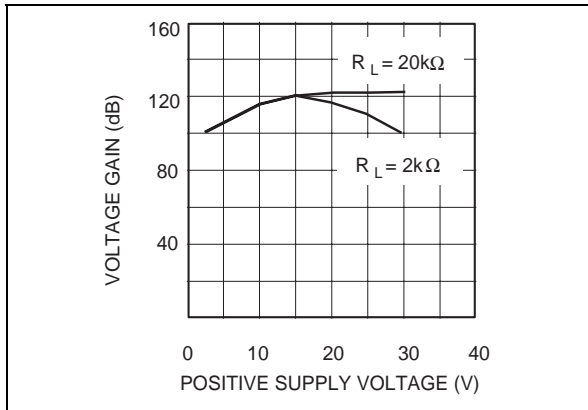
# LM2904WH

Symbol	Parameter	Min.	Typ.	Max.	Unit
$I_{\text{sink}}$	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		$\mu A$
$V_{\text{OPP}}$	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
$V_{\text{OH}}$	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		
$V_{\text{OL}}$	Low Level Output Voltage ( $R_L = 10k\Omega$ ) $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		5	20 20	mV
SR	Slew Rate (Unity gain) $V_{CC} = 15V, V_i = 0.5$ to $3V, R_L = 2k\Omega, C_L = 100\text{pF}$ , $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	0.3 0.2	0.6		V/ $\mu\text{s}$
GBP	Gain Bandwidth Product $f = 100\text{kHz}$ $V_{CC} = 30V, V_{\text{in}} = 10\text{mV}, R_L = 2k\Omega, C_L = 100\text{pF}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$	0.7 0.45	1.1		MHz
THD	Total Harmonic Distortion $f = 1\text{kHz}, A_V = 20\text{dB}, R_L = 2k\Omega, V_o = 2V_{\text{pp}}$ , $C_L = 100\text{pF}, V_{CC} = 30V$		0.02		%
$DV_{\text{io}}$	Input Offset Voltage Drift		7	30	$\mu\text{V}/^\circ\text{C}$
$DI_{\text{io}}$	Input Offset Current Drift		10	300	$\text{pA}/^\circ\text{C}$
$V_{O1}/V_{O2}$	Channel Separation <sup>4)</sup> $1\text{kHz} \leq f \leq 20\text{kHz}$		120		dB

- $V_O = 1.4V, R_S = 0\Omega, 5V < V_{CC}^+ < 30V, 0V < V_{\text{ic}} < V_{CC}^+ - 1.5V$
- The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output, so no loading charge change exists on the input lines
- 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.
- Due to the proximity of external components insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies.

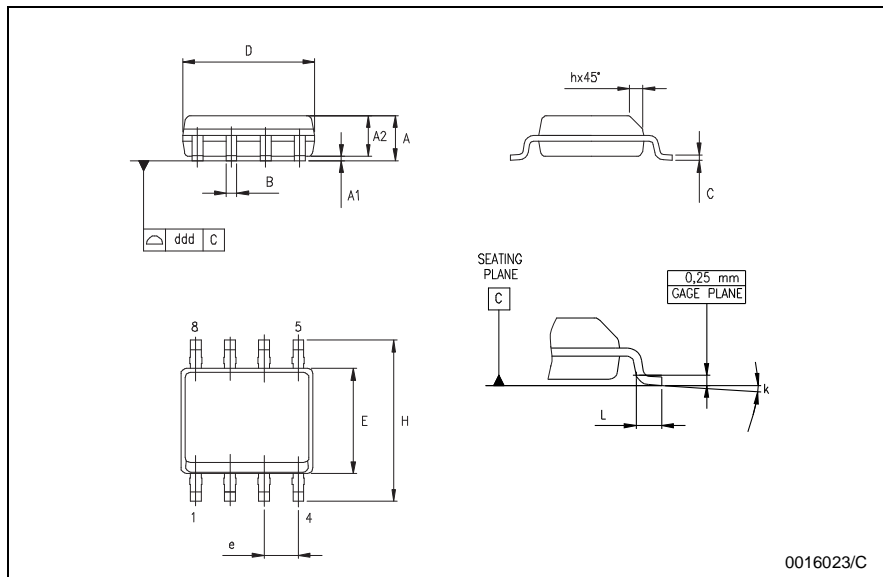






PACKAGE MECHANICAL DATA

SO-8 MECHANICAL DATA						
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.04		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D	4.80		5.00	0.189		0.197
E	3.80		4.00	0.150		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	8° (max.)					
ddd			0.1			0.04



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