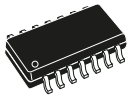
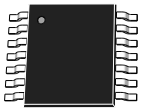
LM2902W

Datasheet

Low-power quad operational amplifier



SO14



TSSOP14

Maturity status link
LM2902W

Features

- Wide gain bandwidth: 1.3 MHz
- Input common-mode voltage range includes negative rail
- Large voltage gain: 100 dB
- Very low supply current per amplifier: 375 µA
- Low input bias current: 20 nA
- Low input offset current: 2 nA
- ESD internal protection: 800 V
- Wide power supply range
- Single supply: 3 V to 30 V
- Dual supplies: ±1.5 V to ±15 V

Description

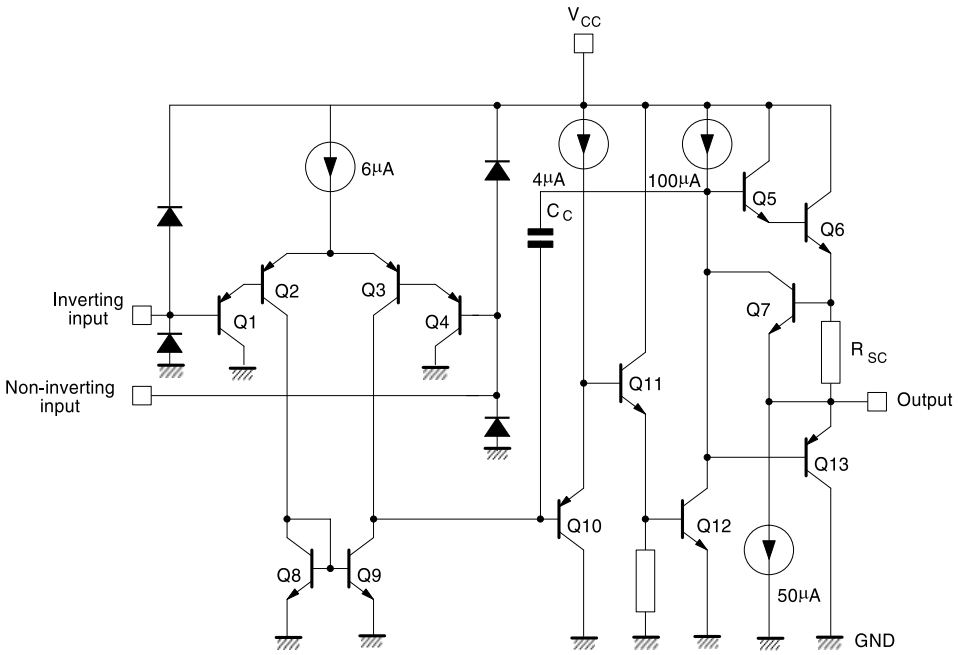
This circuit consists of four independent, high-gain operational amplifiers which have frequency compensation implemented internally and are designed especially for automotive and industrial control systems.

The device operates from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

All the pins are protected against electrostatic discharges up to 800 V.

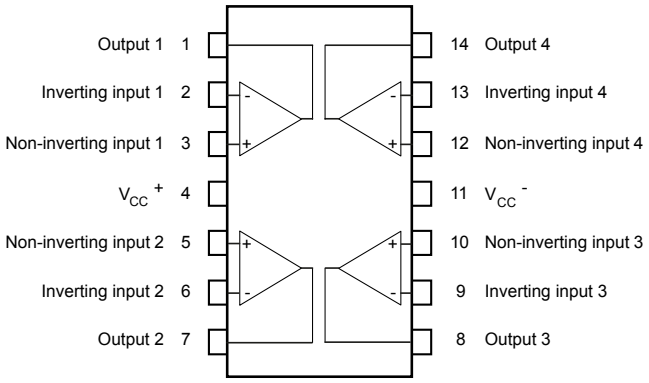
1 Schematic diagram

Figure 1. **Schematic diagram (1/4 LM2902W)**



2 Package pin connections

Figure 2. SO14 and TSSOP14 pin connections (top view)



3 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter		Value	Unit
V_{CC}	Supply voltage		±16 to 32	V
V_{id}	Differential input voltage		32	
V_i	Input voltage		-0.3 to (V_{CC}^+) + 0.3	
	Output short-circuit to ground (1)		Infinite	
I_{in}	Input current (2)		50	mA
T_{stg}	Storage temperature range		-65 to 150	°C
R_{thja}	Thermal resistance junction to ambient (3)	SO14	105	°C/W
		TSSOP14	100	
R_{thjc}	Thermal resistance junction to case (3)	SO14	31	
		TSSOP14	32	
ESD	HBM: human body model (4)		800	V
	MM: machine model (5)		100	
	CDM: charged device model (6)		1500	

1. *Short-circuits from the output to V_{CC}^+ can cause excessive heating and potential destruction. The maximum output current is approximately 20 mA, independent of the magnitude of V_{CC}^+*
2. *This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward biased and thereby acting as an input diode clamp. In addition to this diode action, there is also NPN parasitic action on the IC chip. This transistor action can cause the output voltages of the op amps to go to the V_{CC} voltage level (or to ground for a large overdrive) for the time during which an input is driven negative. This is not destructive and normal output is restored for input voltages higher than -0.3 V.*
3. *$R_{thja/c}$ are typical values.*
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 < 5 Ω). 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
V_{icm}	Common mode input voltage range		(V_{CC}^-) to (V_{CC}^+) - 1.5	
		$T_{min} \leq T_{amb} \leq T_{max}$	(V_{CC}^-) to (V_{CC}^+) - 2	
T_{oper}	Operating free-air temperature range		-40 to 125	°C

4 Electrical characteristics

Table 3. V_{CC}^+ = 5 V, V_{CC}^- = ground, V_O = 1.4 V, T_{amb} = 25 °C (unless otherwise stated)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage (1)	LM2902W		2	7	mV
		LM2902AW			2	
		$T_{min} \le T_{amb} \le T_{max}$, LM2902W			9	
		$T_{min} \le T_{amb} \le T_{max}$, LM2902AW			4	
$\Delta V_{io}/\Delta T$	Input offset voltage drift			7	30	µV/°C
I_{io}	Input offset current	T_{amb} = 25 °C		2	30	nA
		$T_{min} \le T_{amb} \le T_{max}$			40	
DI_{io}	Input offset current drift			10	200	pA/°C
I_{ib}	Input bias current (2)	T_{amb} = 25 °C		20	150	nA
		$T_{min} \le T_{amb} \le T_{max}$			300	
A_{vd}	Large signal voltage gain	V_{CC}^+ = 15 V, R_L = 2 kΩ, V_o = 1.4 V to 11.4 V, T_{amb} = 25 °C	50	100		V/mV
		V_{CC}^+ = 15 V, R_L = 2 kΩ, V_o = 1.4 V to 11.4 V, $T_{min} \le T_{amb} \le T_{max}$	25			
SVR	Supply voltage rejection ratio	$R_S \le$ 10 kΩ, T_{amb} = 25 °C	65	110		dB
		$R_S \le$ 10 kΩ, $T_{min} \le T_{amb} \le T_{max}$	65			
I_{CC}	Supply current (all op amps, no load)	T_{amb} = 25 °C, V_{CC}^+ = 5 V		0.7	1.2	mA
		T_{amb} = 25 °C, V_{CC}^+ = 30 V		1.5	3	
		$T_{min} \le T_{amb} \le T_{max}$, V_{CC}^+ = 5 V		0.9	1.2	
		$T_{min} \le T_{amb} \le T_{max}$, V_{CC}^+ = 30 V		1.5	3	
CMR	Common-mode rejection ratio	$R_S \le$ 10 kΩ, T_{amb} = 25 °C	70	80		dB
		$R_S \le$ 10 kΩ, $T_{min} \le T_{amb} \le T_{max}$	60			
I_o	Output short-circuit current	V_{id} = 1 V, V_{CC}^+ = 15 V, V_o = 2 V	20	40	70	mA
I_{sink}	Output sink current	V_{id} = -1 V, V_{CC}^+ = 15 V, V_o = 2 V	10	20		
		V_{id} = -1 V, V_{CC}^+ = 15 V, V_o = 0.2 V	12	50		µA
V_{OH}	High-level output voltage	V_{CC}^+ = 30 V, R_L = 2 kΩ, T_{amb} = 25 °C	26	27		V
		V_{CC}^+ = 30 V, R_L = 2 kΩ, T_{min} = T_{amb} = T_{max}	26			
		V_{CC}^+ = 30 V, R_L = 10 kΩ, T_{amb} = 25 °C	27	28		
		V_{CC}^+ = 30 V, R_L = 10 kΩ, T_{min} = T_{amb} = T_{max}	27			
		V_{CC}^+ = 5 V, R_L = 2 kΩ, T_{amb} = 25 °C	3.5			
		V_{CC}^+ = 5 V, R_L = 2 kΩ, T_{min} = T_{amb} = T_{max}	3			
V_{OL}	Low level output voltage	R_L = 10 kΩ, T_{amb} = 25 °C		5	20	mV
		R_L = 10 kΩ, T_{min} = T_{amb} = T_{max}			20	
SR	Slew rate	V_{CC}^+ = 15 V, V_{in} = 0.5 to 3 V, R_L = 2 kΩ, C_L = 100 pF, unity gain	0.24	0.4		V/µs
		V_{CC}^+ = 15 V, V_{in} = 0.5 to 3 V, R_L = 2 kΩ, C_L = 100 pF, unity gain, $T_{min} \le T_{amb} \le T_{max}$	0.14			V/µs

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
GBP	Gain bandwidth product	V_{CC}^+ = 30 V, V_{in} = 10 mV, R_L = 2 kΩ, C_L = 100 pF		1.3		MHz
THD	Total harmonic distortion	f = 1 kHz, A_V = 20 dB, R_L = 2 kΩ, V_o = 2 V_{pp}, C_L = 100 pF, V_{CC}^+ = 30 V		0.015		%
e_n	Equivalent input noise voltage	f = 1 kHz, R_S = 100 Ω, V_{CC}^+ = 30 V		40		nV/√Hz
$V_{O1}/V_{O}2$	Channel separation (3)	1 kHz ≤ f ≤ 20 kHz		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 load 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 as this type of capacitance increases at higher frequencies.*

5 Electrical characteristic curves

Figure 3. Input bias current vs. T_{amb}

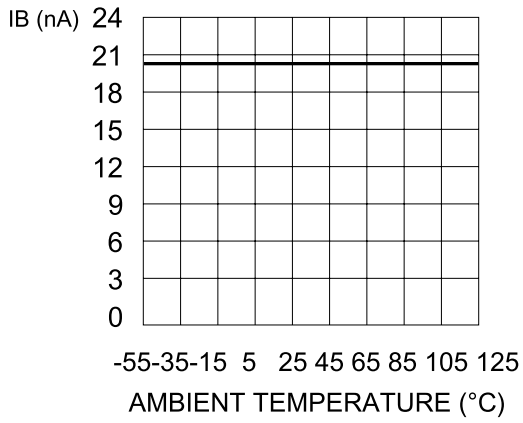


Figure 4. Input voltage range

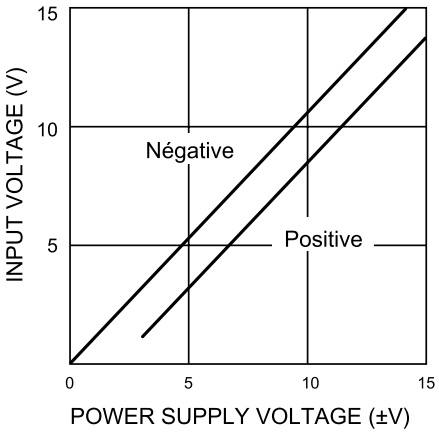


Figure 5. Current limiting

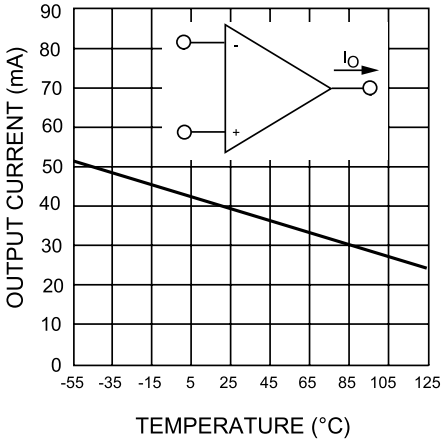


Figure 6. Supply current

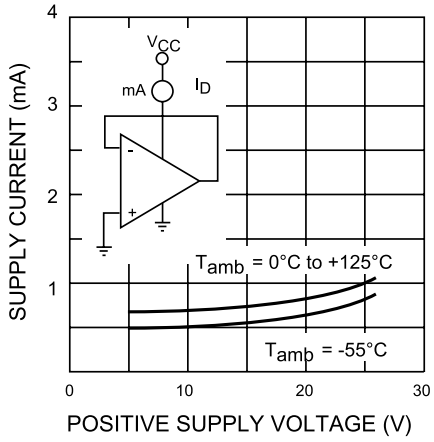


Figure 7. Gain bandwidth product

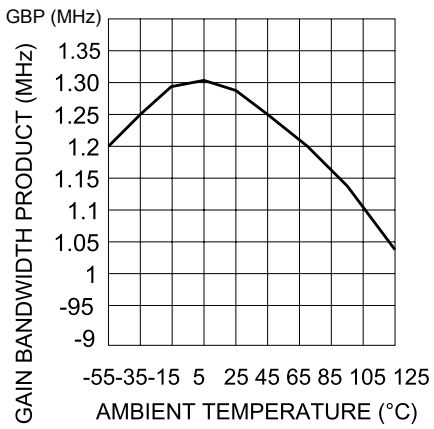


Figure 8. Voltage follower pulse response (V_{CC} = 15 V)

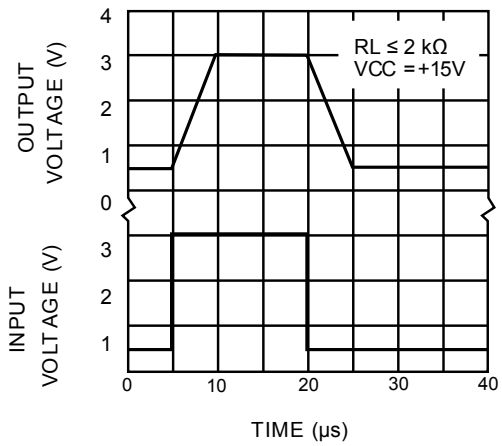


Figure 9. Common-mode rejection ratio

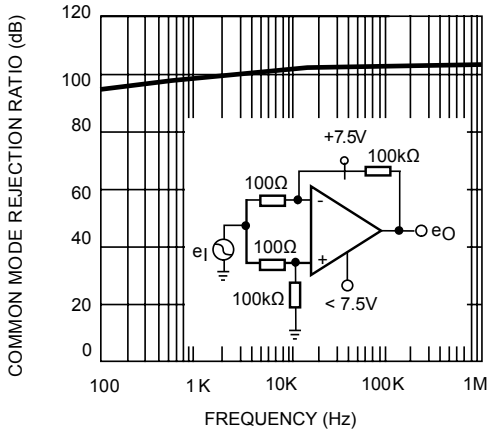


Figure 10. Output characteristics (sink)

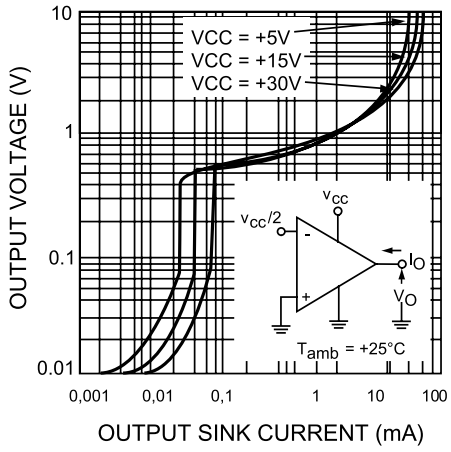


Figure 11. Open-loop frequency response

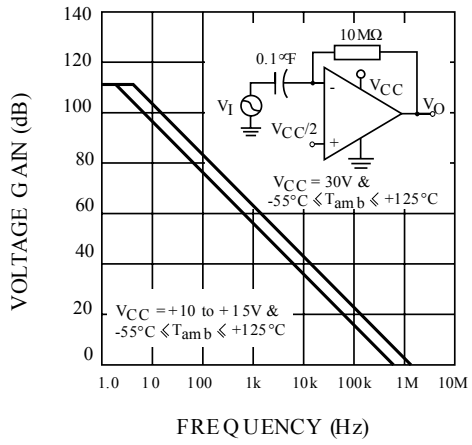


Figure 12. Voltage follower pulse response (V_{CC} = 30 V)

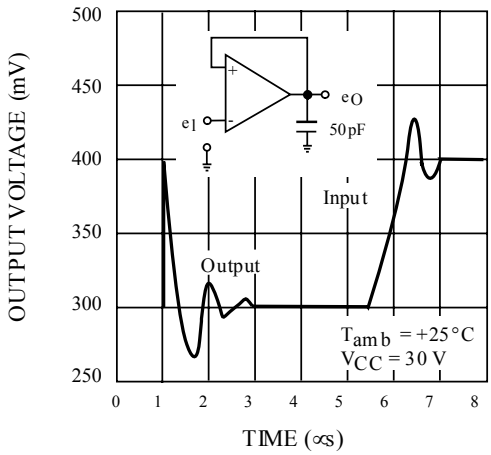


Figure 13. Large signal frequency response

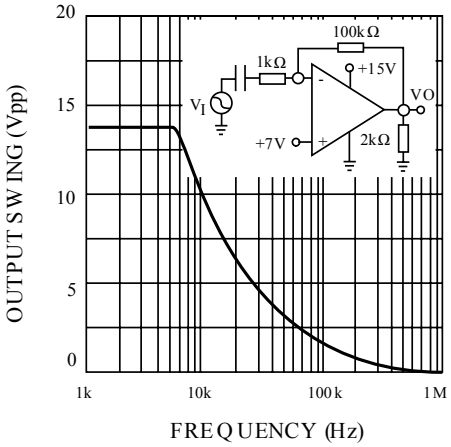


Figure 14. Output characteristics (source)

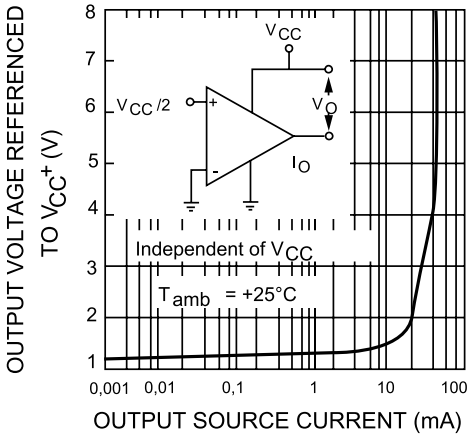


Figure 15. Input current

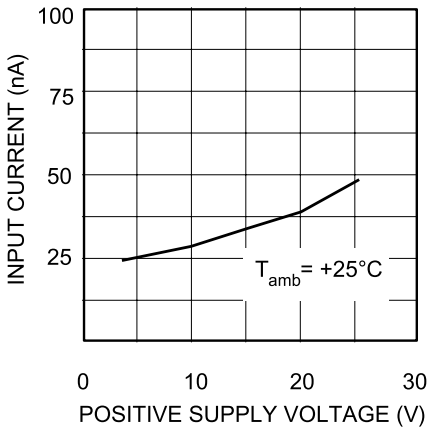


Figure 16. Voltage gain

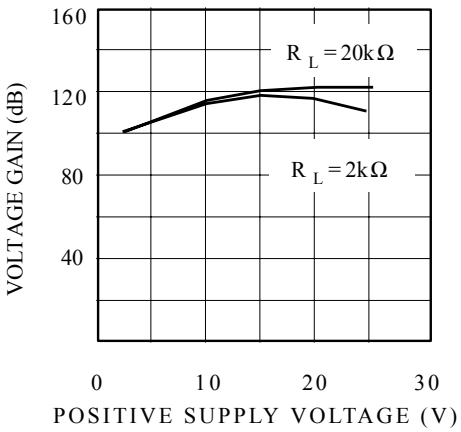


Figure 17. Power supply and common-mode rejection ratio

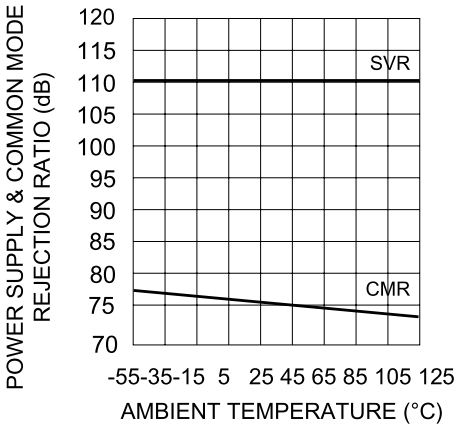


Figure 18. Large signal voltage gain

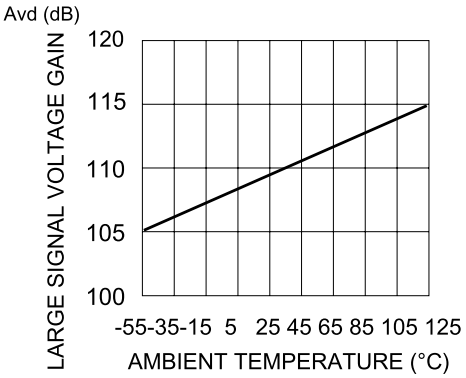


Figure 19. Bode diagram at 25 °C

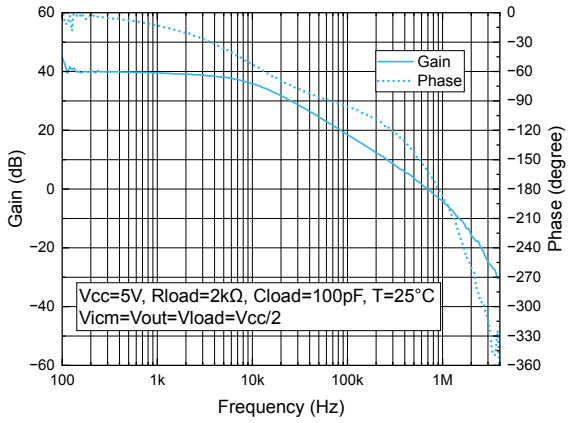


Figure 20. Bode diagram at 125 °C

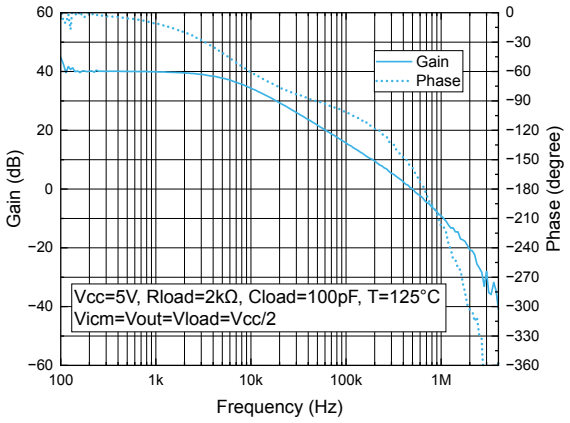


Figure 21. **Bode diagram at - 40 °C**

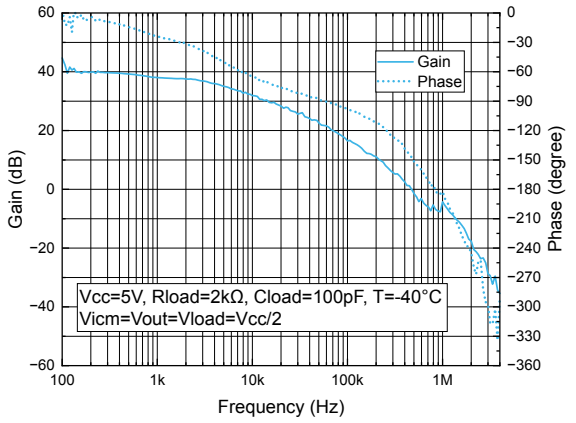
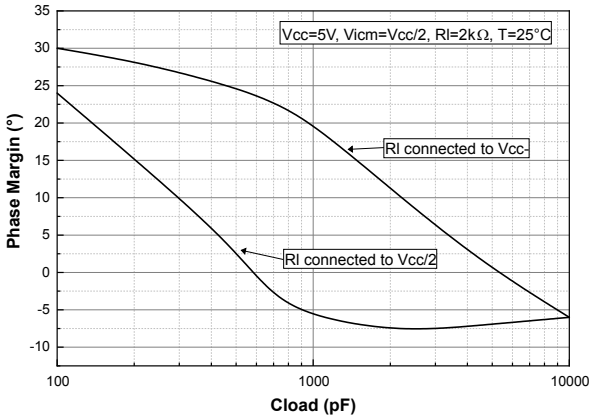


Figure 22. **Phase margin vs. capacitive load**



6 Typical single-supply applications

Figure 23. AC coupled inverting amplifier

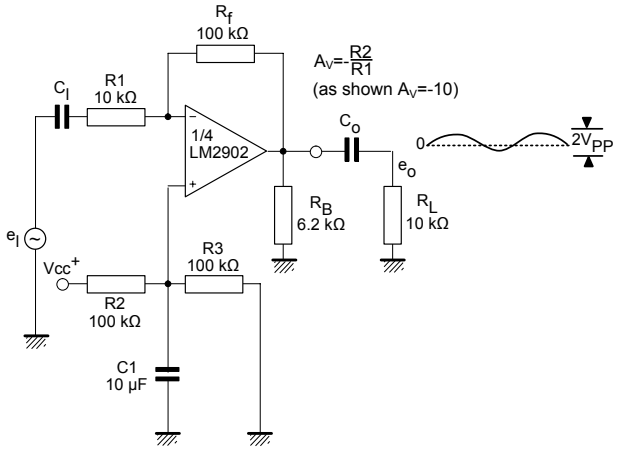


Figure 24. AC coupled non-inverting amplifier

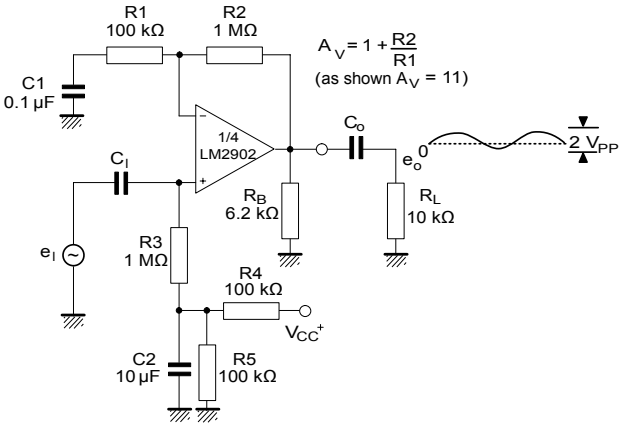


Figure 25. Non-inverting DC gain

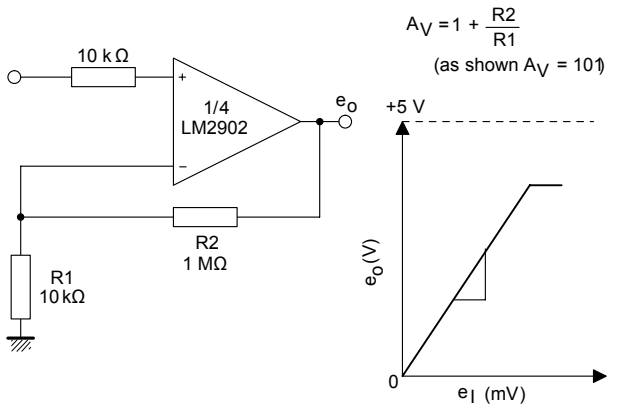
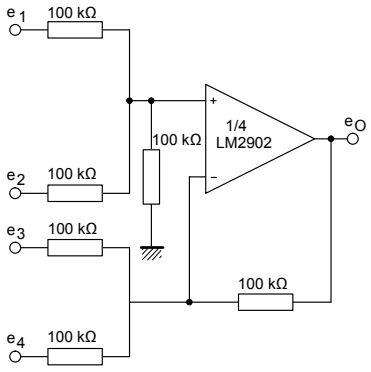
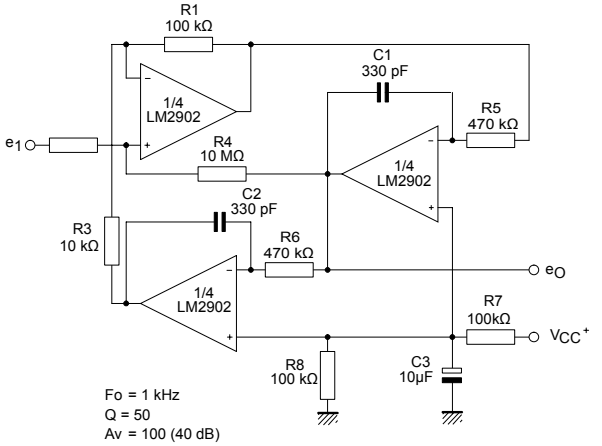


Figure 26. DC summing amplifier



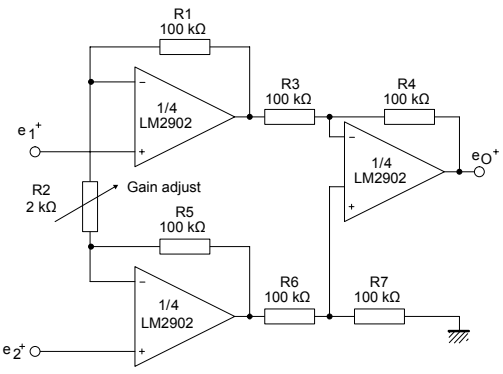
e0 = e1 + e2 - e3 - e4
where (e1 + e2) ≥ (e3 + e4)
to keep e0 ≥ 0 V

Figure 27. Active bandpass filter



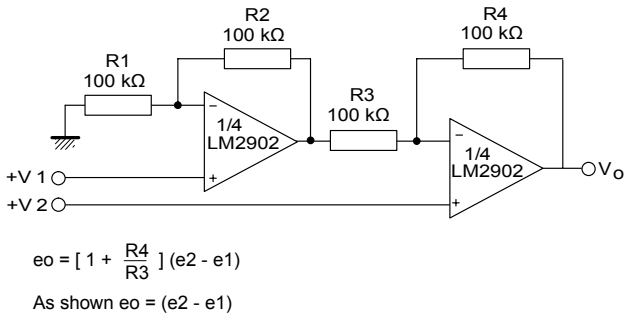
Fo = 1 kHz
Q = 50
Av = 100 (40 dB)

Figure 28. High input Z adjustable gain DC instrumentation amplifier



If R1 = R5 and R3 = R4 = R6 = R7
eo = [1 + 2R1/R2] (e2 - e1)
As shown eo = 101 (e2 - e1)

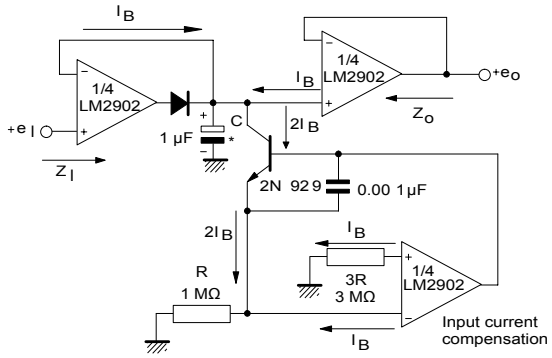
Figure 29. High input Z, DC differential amplifier



$eo = [\,1 + \frac{R4}{R3}\,](e2 - e1)$

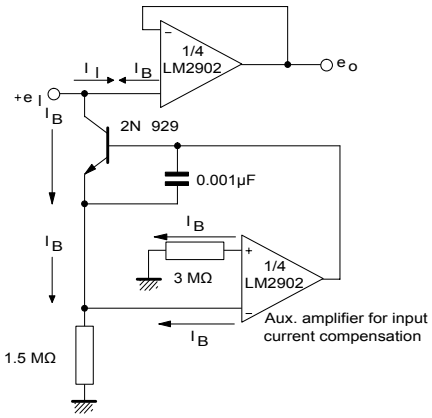
As shown eo = (e2 - e1)

Figure 30. Low drift peak detector



* Polycarbonate or polyethylene

Figure 31. Using symmetrical amplifiers to reduce input current (general concept)



7 Macromodel

An accurate macromodel of the LM2902W is available on STMicroelectronics' web site at **www.st.com**. This model is a trade-off between accuracy and complexity (that is, time simulation) of the LM2902W operational amplifiers. It emulates the nominal performances of a typical device within the specified operating conditions mentioned in the datasheet. It also helps to validate a design approach and to select the right operational amplifier, *but it does* not replace on-board measurements.

8 Package information

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.

8.1 SO-14 package information

Figure 32. SO-14 package outline

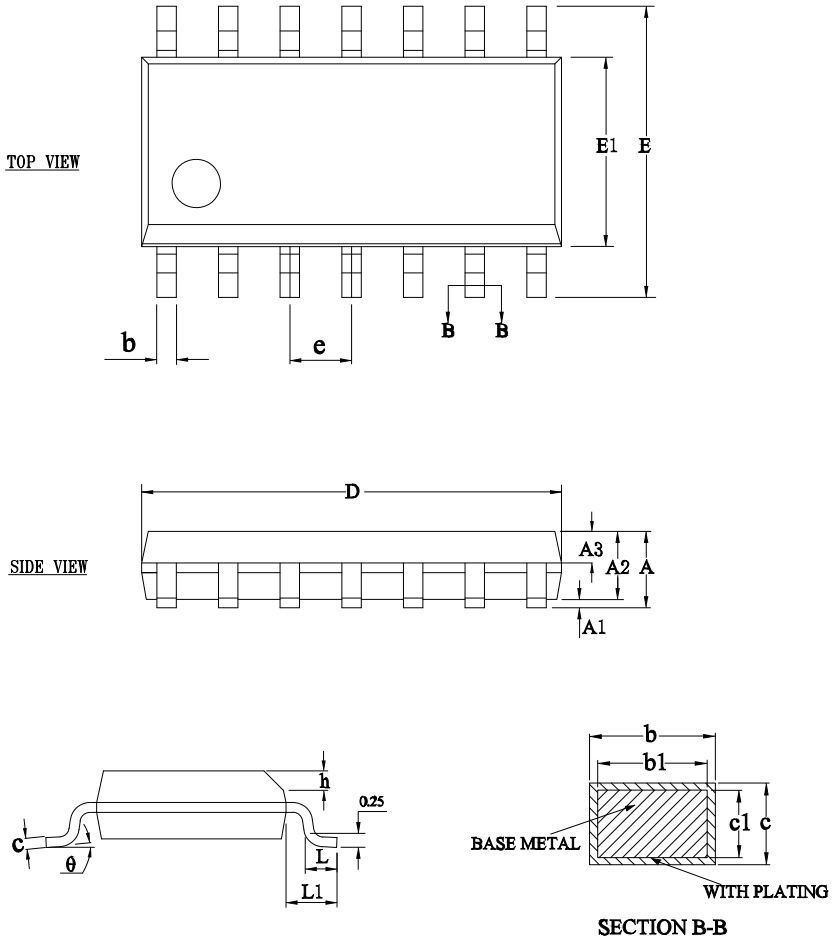
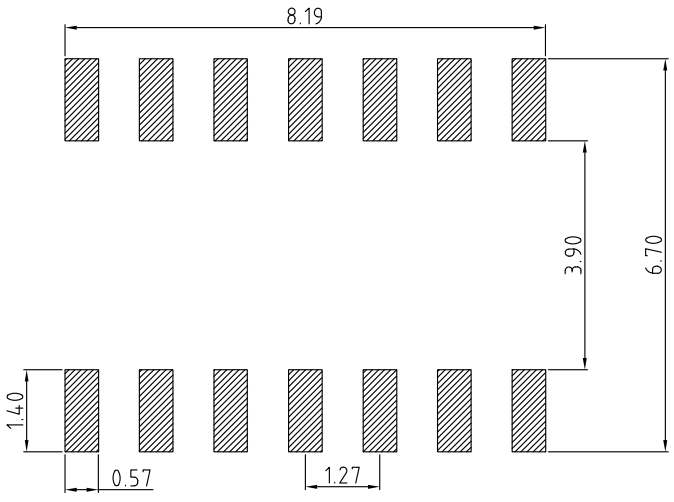


Table 4. **SO-14 package mechanical data**

Dim.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.225	0.004		0.009
A2	1.30	1.40	1.50	0.051	0.055	0.059
A3	0.60	0.65	0.70	0.024	0.026	0.028
b	0.39		0.47	0.015		0.019
b1	0.38	0.41	0.44	0.015	0.016	0.017
c	0.20		0.24	0.008		0.009
c1	0.19	0.20	0.21	0.0075	0.0079	0.0083
D	8.55	8.65	8.75	0.337	0.341	0.344
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 BSC			0.050 BSC		
h	0.25		0.50	0.010		0.020
L	0.50		0.80	0.020		0.031
L1	1.05 REF			0.041 REF		
θ	8° (max)					

Figure 33. **SO-14 recommended footprint**



8.2 TSSOP-14 package information

Figure 34. **TSSOP-14 package outline**

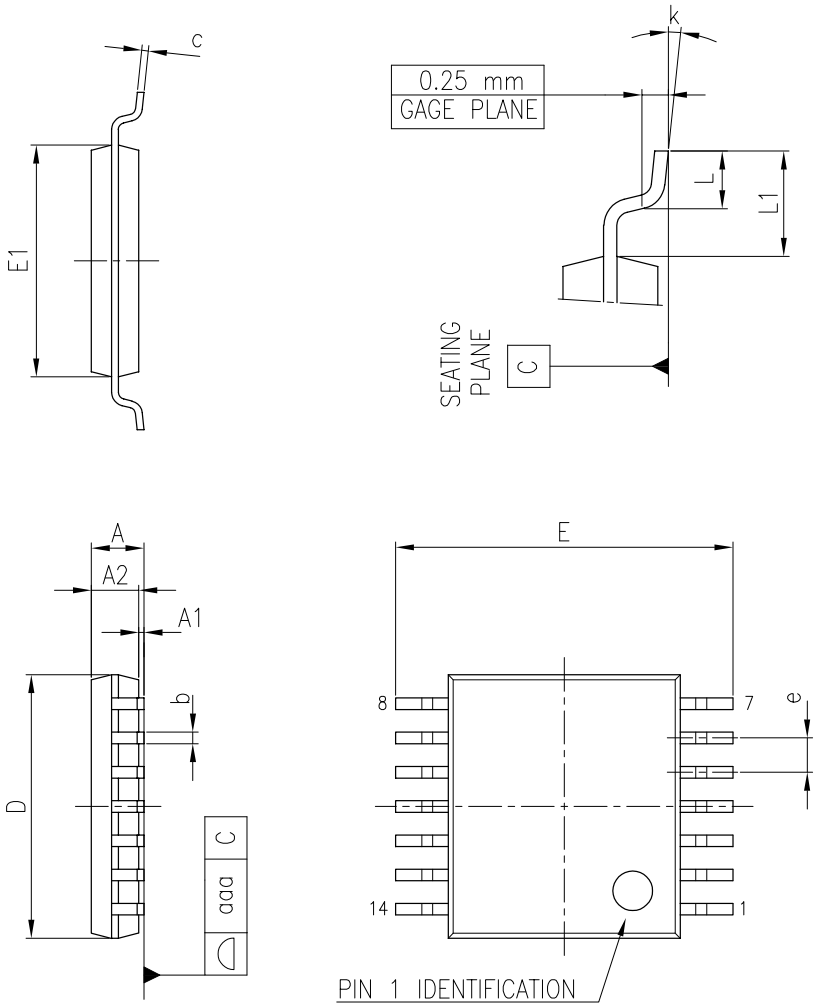
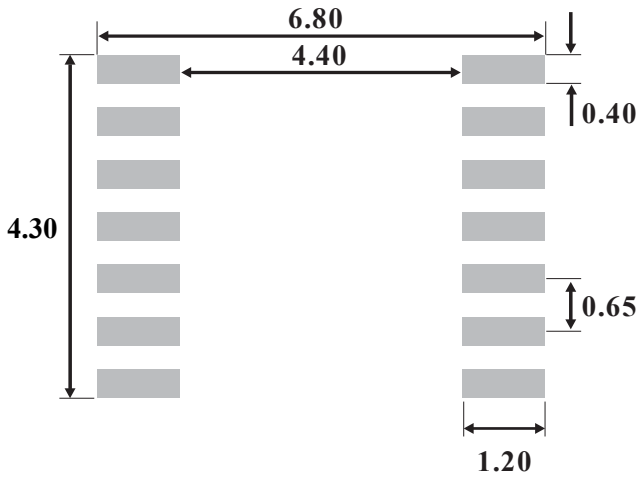


Table 5. **TSSOP-14 package mechanical data**

Dim.	Dimension					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.047
A1	0.05		0.15	0.002		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.008
D	4.90	5.00	5.10	0.193	0.197	0.201
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
e	0.65 BSC			0.25 BSC		
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1.00			0.039	
k	8° (max)					
aaa			0.10			0.004

Figure 35. **TSSOP-14 recommended footprint**



9 Ordering information

Table 6. Order codes

Order code	Temperature range	Package	Packing	Marking
LM2902WDT	-40 °C to 125 °C	SO14	Tape and reel	2902W
LM2902WYDT (1)		SO14 (automotive grade level)		2902WY
LM2902AWYDT (1)				2902AWY
LM2902WPT		TSSOP14		2902W
LM2902WYPT (1)		TSSOP14 (automotive grade level)		2902WY
LM2902AWYPT (1)				2902AWY

1. *Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent.*

Revision history

Table 7. **Document revision history**

Date	Revision	Changes
01-Sep-2003	1	Initial release.
01-Nov-2005	2	Table data reformatted for easier use in Electrical characteristics on page 4. Minor grammatical and formatting changes throughout.
01-Jan-2006	3	LM2902WYPT PPAP reference inserted in order codes table, see Section 7 on page 16.
01-May-2006	4	Minimum value of slew rate at 25°C and on full temperature range added in Table 3 on page 5.
20-Jul-2007	5	Corrected document title to “quad operational amplifier”. Corrected ESD value for HBM to 800V. Corrected thermal resistance junction to ambient values in Table 1: Absolute maximum ratings. Updated electrical characteristics curves. Added Section 5: Macromodel. Added automotive grade order codes in Section 7 on page 16.
15-Jan-2008	6	Corrected footnotes for automotive grade order codes.
17-Oct-2008	7	Added enhanced Vio version: LM2902AW. Corrected V_{OH} min parameter at V_{cc}=5V in Table 3 on page 5.
16-Feb-2012	8	Modified Chapter 5: Macromodel. Deleted LM2902WYD and LM2902AWYD order codes from Table 7 and modified status of LM2902WYPT and LM2902AWYPT order codes.
22-Jul-2013	9	Table 3: DV_{io} replaced with $\Delta V_{io}/\Delta T$ Table 7: Removed the order codes LM2902WN and LM2902WD; replaced the order codes LM2902WDT and LM2902AWDT with LM2902WYDT and LM2902AWYDT respectively.
19-Feb-2016	10	Updated layout. Removed DIP14 package and all information pertaining to it Removed “D, plastic micropackage” and “P, thin shrink small outline package” respectively from the SO14 and TSSOP14 silhouettes. Section 8.1: "SO14 package information": replaced SO14 package outline and mechanical data. Section 8.2: "TSSOP14 package information": updated E1 max mm value, L1 value, and added "aaa" information. Table 6: "Order codes": added order code LM2902WDT.
17-Mar-2025	11	Added new Figure 19, Figure 20, Figure 21 and Figure 22.

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