Preliminary Data Sheet
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microelectronics group

Lucent Technologies
Bell Labs Innovations

LUCV5002 Dual Video Operational Amplifier

Features

The LUCV5002 is a low-cost dual video operational amplifier optimized for applications requiring high output drive capability, such as unshielded twisted pairs in a telephony or data communications environment from –40 °C to +85 °C.

- Output peak current in excess of 150 mA
- Can drive any capacitive load for Av = +3/–2
- Unity gain stable up to 10 pF loads
- Output swing to within 2 V of either supply
- Gain flatness <1 dB, dc to 30 MHz (Av = +3)
- Slew rate of 500 V/µs
- Dual or single power supply up to 12 V
- Quiescent current varies by <2% from –40 °C to +85 °C

Applications

- Driving unshielded twisted pairs
  — ATM LAN UTP
  — FTTC UTP
- 50 Ω or 75 Ω cable driver

Description

The LUCV5002 is a wideband, dual voltage-feedback operational amplifier designed for applications where high-speed, high-current (150 mA) driving capabilities are essential.

The LUCV5002 is optimized for closed-loop voltage gains of ±3 (9.5 dB) in each amplifier. This operating condition provides gain flatness of better than 1 dB up to 30 MHz, and a slew rate of 500 V/µs, while driving up to 150 mA (6 V peak-to-peak) into a transmission line with low distortion for monotone signals and less than 10% ringing for pulse signals. It is stable for any capacitive load at Av = +3/–2, and stable over process and temperature variations with CL up to 10 pF at Av = +1.

The dual amplifiers are exact mirrors of each other, with individual power supply bonding pads for optimized matching and isolation. The LUCV5002 can operate on either single or dual power supplies with a range of 5 V to 12 V, requiring 2 V of headroom from each power supply.

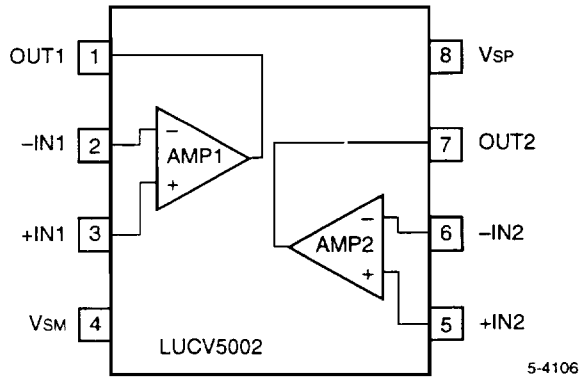


Figure 1. Functional Block Diagram

Pin Information

Table 1. Pin Descriptions

Pin	Symbol	Description
1	OUT1	Amplifier #1 Output
2	–IN1	Amplifier #1 Negative Input
3	+IN1	Amplifier #1 Positive Input
4	VSM	Negative Power Supply Voltage
5	+IN2	Amplifier #2 Positive Input
6	–IN2	Amplifier #2 Negative Input
7	OUT2	Amplifier #2 Output
8	VSP	Positive Power Supply Voltage

Functional Description

The LUCV5002 is a dual, voltage-feedback, operational amplifier designed to drive up to 150 mA into transmission lines at 30 MHz.

Each amplifier is optimized for a closed-loop voltage gain of 3 (9.5 dB), either inverting or noninverting, set by external resistors. The LUCV5002 is recommended for voltage gains between 2 (6 dB) and 5 (14 dB). For higher gains, the otherwise similar LUCV5006 is preferred.

The LUCV5002 is temperature compensated to minimize performance variations from –40 °C to 85 °C. Its input impedance is high (typically 8 MΩ ll 1 pF at Av = +1). Internal compensation provides typical input bias currents of ±400 nA.

The differential input stage is followed by a folded cascode stage, frequency compensated to ensure stability while permitting a slew rate of 500 V/µs. With a voltage gain of 3, the LUCV5002 is stable for any capacitive load.

Using cascaded emitter followers in the output stage (hence, the 2 V headroom requirement from each supply), each LUCV5002 amplifier can deliver over 150 mA peak, yet draw only 8.5 mA typical quiescent current.

With quiescent output stage feedthrough current in excess of 1 mA, the LUCV5002 exhibits minimal crossover distortion.

Absolute Maximum Ratings

Stresses in excess of absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of this data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Symbol	Value
Supply Voltage	$V_{8, 4}$	12.0 V
Output Current	I_1; I_7	±210 mA
Power Dissipation	P	500 mW
Differential Input Voltages	$V_{2, 3}$; $V_{5, 6}$	±1.0 V
Pin Voltages Above VSP	$V_{any\ other\ pin, 8}$	0.3 V
Pin Voltage Below VSM	$V_{4, any\ other\ pin}$	0.3 V
Storage Temperature	T_{stg}	–40 °C to +125 °C
Junction Temperature	T_j	165 °C

Electrical Characteristics (T_A = 25 °C)

For Tables 2—8 (T_A = 25 °C), V_{SP} = +5 V, V_{SM} = –5 V, R_L = 50 Ω unless otherwise noted. Parametric values in Tables 4—8 are from design simulations; parameters are 100% tested only when specifically noted.

Table 2. dc Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Quiescent Current*	Per amplifier.	7	8.5	10	mA
Input Offset Voltage*	—	—	±2	±10	mV
Input Bias Currents*	—	—	—	±900	nA
dc Output Impedance	See Figure 3, $R_L = \infty$.	0.028	0.03	0.04	Ω

* 100% tested.

Table 3. dc Performance

Parameter	Conditions	Min	Typ	Max	Unit
Output Current Drive*	R_L = 2 Ω, A_V = +1. See Figure 4.	—	±210†	—	mA
Input Common-mode Range‡	—	±3.0	—	—	V
Output Voltage Range‡	R_L = 1 kΩ R_L = 20 Ω	±2.8 ±2.4	— —	— —	V V
dc Open-loop Voltage Gain‡	See Figure 5.	45	50	55	dB

* In addition, caution must be taken not to exceed the power rating of the package which has a thermal resistance of 150 °C/W.
† Although the typical current drive is over 300 mA, the maximum current is limited to ±210 mA by IC metallization; hence, caution must be taken not to exceed this value in steady-state operation since the LUCV5002 does not provide current-limit protection.
‡ 100% tested.

Table 4. ac Performance

Parameter	Conditions	Min	Typ	Max	Unit
Bandwidth –3 dB					
A_V = +1	See Figure 6.	150	220	340	MHz
A_V = +2	See Figure 7.	60	120	210	MHz
Gain Flatness, dc – 30 MHz	See Figure 9.	—	0.6	1.4	dB
Gain Peaking					
A_V = +1	See Figure 6.	2	3	6	dB
A_V = +2	See Figure 7.	0	0.1	1	dB
Gain Matching A_V = +3/–3	See Figure 8.	—	0.8	—	dB
Slew Rate	—	340	489	705	V/µs

Electrical Characteristics (T_A = 25 °C) (continued)

Table 5. Stability with No Capacitive Load

Parameter	Conditions	Min	Typ	Max	Unit
Gain Margin					
A_V = +1	See Figure 5.	7.35	11.3	13.8	dB
A_V = +3/–2	See Figure 9 for gain setting.	16	20	22	dB
Phase Margin					
A_V = +1	See Figure 5.	32.9	43	48.9	Degrees
A_V = +3/–2	See Figure 9 for setup.	66	71	74	Degrees

Table 6. Stability with Capacitive Load

Parameter	Conditions	Min	Typ	Max	Unit
Gain Margin					
A_V = +1, C_L = 10 pF	See Figure 5.	2.7	6.8	9.84	dB
A_V = +3/–2, C_L = 10000 pF	See Figure 9 for gain setting.	5.2	7	8.6	dB
Phase Margin					
A_V = +1, C_L = 10 pF	See Figure 5.	17	34	43.4	Degrees
A_V = +3/–2, C_L = 10000 pF	See Figure 9 for gain setting.	5.6	6.5	7.95	Degrees

Table 7. Dynamic Performance

Parameter	Conditions	Min	Typ	Max	Unit
Propagation Delay (50% input to 50% output)					
A_V = +1, 2 V peak to peak	See Figure 10.	0.4	1	2	ns
A_V = +3, 6 V peak to peak*	See Figure 12.	2.2	4.2	7	ns
Rise/Fall Times (10% to 90%)					
A_V = +1, 2 V peak to peak	See Figure 10.	3.5	4	4.5	ns
A_V = +3, 6 V peak to peak*	See Figure 12.	7.2	9.8	14	ns
Overshoot Rising					
A_V = +1, 2 V peak to peak	See Figure 10.	4	10	28	%
A_V = +3, 6 V peak to peak*	See Figure 12.	4.1	4.5	5.2	%
Overshoot Falling					
A_V = +1, 2 V peak to peak	See Figure 10.	0	4	6	%
A_V = +3, 6 V peak to peak*	See Figure 12.	0	0	0	%
Settling Time (less than 0.1%)					
A_V = +1, 2 V peak to peak	See Figure 10.	—	10	30	ns
A_V = +3, 6 V peak to peak*	See Figure 12.	19	25	—	ns

* Input rise time = 1 ns.

Table 8. Operating Conditions

Parameter	Conditions	Min	Typ	Max	Unit
Operating Range					
Dual Supplies	—	±3	—	±6	V
Single Supply	—	5	—	12	V
Quiescent Current*	V_{IN} = 0, A_V = +1, R_L = 10 kΩ.	14	17	20	mA

* 100% tested.

Electrical Characteristics (T_A = 0 °C to 70 °C)

For Tables 9—15 (T_A = 0 °C to 70 °C), V_{SP} = +5 V, V_{SM} = −5 V, R_L = 50 Ω unless otherwise noted. Parametric values in Tables 9—15 are from design simulations; parameters are not 100% tested.

Table 9. dc Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Quiescent Current	Per amplifier.	7	8.5	10	mA
Input Offset Voltage	—	—	±2	±10	mV
Input Bias Currents	—	—	—	±1100	nA

Table 10. dc Performance

Parameter	Conditions	Min	Typ	Max	Unit
Output Current Drive*	R_L = 2 Ω, A_V = +1. See Figure 4.	—	±210†	—	mA
Input Common-mode Range	—	±3.0	—	—	V
Output Voltage Range	R_L = 1 kΩ R_L = 20 Ω	±2.8 ±2.4	— —	— —	V V
dc Open-loop Voltage Gain	See Figure 5.	45	50	55	dB

* In addition, caution must be taken not to exceed the power rating of the package which has a thermal resistance of 150 °C/W.
† Although the typical current drive is over 300 mA, the maximum current is limited to ±210 mA by IC metallization; hence, caution must be taken not to exceed this value in steady-state operation since the LUCV5002 does not provide current-limit protection.

Table 11. ac Performance

Parameter	Conditions	Min	Typ	Max	Unit
Bandwidth −3 dB					
A_V = +1	See Figure 6.	150	220	340	MHz
A_V = +2	See Figure 7.	60	120	210	MHz
Gain Flatness, dc – 30 MHz	See Figure 9.	—	0.6	1.4	dB
Gain Peaking					
A_V = +1	See Figure 6.	2	3	10	dB
A_V = +2	See Figure 7.	0	0.1	2	dB
Gain Matching A_V = +3/−3	See Figure 8.	—	0.8	—	dB
Slew Rate	—	337	489	750	V/µs

Electrical Characteristics (T_A = 0 °C to 70 °C) (continued)

Table 12. Stability with No Capacitive Load

Parameter	Conditions	Min	Typ	Max	Unit
Gain Margin					
A_V = +1	See Figure 5.	7.6	12	14.47	dB
A_V = +3/–2	See Figure 9 for gain setting.	12.6	20	22	dB
Phase Margin					
A_V = +1	See Figure 5.	33.8	43.8	49.6	Degrees
A_V = +3/–2	See Figure 9 for setup.	66	71	74	Degrees

Table 13. Stability with Capacitive Load

Parameter	Conditions	Min	Typ	Max	Unit
Gain Margin					
A_V = +1, C_L = 10 pF	See Figure 5.	0.4	6.8	9.8	dB
A_V = +3/–2, C_L = 10000 pF	See Figure 9 for gain setting.	4.3	7	8.6	dB
Phase Margin					
A_V = +1, C_L = 10 pF	See Figure 5.	1.77	34	43	Degrees
A_V = +3/–2, C_L = 10000 pF	See Figure 9 for gain setting.	4.7	6.5	7.95	Degrees

Table 14. Dynamic Performance

Parameter	Conditions	Min	Typ	Max	Unit
Propagation Delay (50% input to 50% output)					
A_V = +1, 2 V peak to peak	See Figure 10.	0.4	1	2	ns
A_V = +3, 6 V peak to peak*	See Figure 12.	2.4	4.2	7.8	ns
Rise/Fall Times (10% to 90%)					
A_V = +1, 2 V peak to peak	See Figure 10.	3	4	4.5	ns
A_V = +3, 6 V peak to peak*	See Figure 12.	7.2	9.8	16	ns
Overshoot Rising					
A_V = +1, 2 V peak to peak	See Figure 10.	4	10	28	%
A_V = +3, 6 V peak to peak*	See Figure 12.	4.1	4.5	5.3	%
Overshoot Falling					
A_V = +1, 2 V peak to peak	See Figure 10.	0	4	6	%
A_V = +3, 6 V peak to peak*	See Figure 12.	0	0	0	%
Settling Time (less than 0.1%)					
A_V = +1, 2 V peak to peak	See Figure 10.	—	10	30	ns
A_V = +3, 6 V peak to peak*	See Figure 12.	20	25	—	ns

* Input rise time = 1 ns.

Table 15. Operating Conditions

Parameter	Conditions	Min	Typ	Max	Unit
Operating Range					
Dual Supplies	—	±3	—	±6	V
Single Supply	—	5	—	12	V
Quiescent Current	V_{IN} = 0, A_V = +1, R_L = 10 kΩ.	14	17	20	mA

Electrical Characteristics (T_A = –40 °C to +85 °C)

For Tables 16—22 (T_A = –40 °C to +85 °C), V_{SP} = +5 V, V_{SM} = –5 V, R_L = 50 Ω unless otherwise noted. Parametric values in Tables 16—22 are estimates derived from design simulations; parameters are not 100% tested.

Table 16. dc Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Quiescent Current	Per amplifier.	7	8.5	10	mA
Input Offset Voltage	—	—	±2	±10	mV
Input Bias Currents	—	—	—	±1800	nA

Table 17. dc Performance

Parameter	Conditions	Min	Typ	Max	Unit
Output Current Drive*	R_L = 2 Ω, A_V = +1. See Figure 4.	—	210†	—	mA
Input Common-mode Range	—	±3.0	—	—	V
Output Voltage Range	R_L = 1 kΩ R_L = 20 Ω	±2.8 ±2.4	— —	— —	V V
dc Open-loop Voltage Gain	See Figure 5.	45	50	55	dB

* In addition, caution must be taken not to exceed the power rating of the package which has a thermal resistance of 150 °C/W.
† Although the typical current drive is over 300 mA, the maximum current is limited to ±210 mA by IC metallization; hence, caution must be taken not to exceed this value in steady-state operation since the LUCV5002 does not provide current-limit protection.

Table 18. ac Performance

Parameter	Conditions	Min	Typ	Max	Unit
Bandwidth –3 dB					
A_V = +1	See Figure 6.	150	220	340	MHz
A_V = +2	See Figure 7.	60	120	210	MHz
Gain Flatness, dc – 30 MHz	See Figure 9.	—	0.6	1.4	dB
Gain Peaking					
A_V = +1	See Figure 6.	1.6	3	12	dB
A_V = +2	See Figure 7.	0	0.1	3	dB
Gain Matching A_V = +3/–3	See Figure 8.	—	0.8	—	dB
Slew Rate	—	310	489	818	V/µs

Electrical Characteristics (T_A = –40 °C to +85 °C) (continued)

Table 19. Stability with No Capacitive Load

Parameter	Conditions	Min	Typ	Max	Unit
Gain Margin					
A_V = +1	See Figure 5.	3.26	12	15.3	dB
A_V = +3/–2	See Figure 9 for gain setting.	12	20	22	dB
Phase Margin					
A_V = +1	See Figure 5.	17.4	43	51.6	Degrees
A_V = +3/–2	See Figure 9 for setup.	66	71	74	Degrees

Table 20. Stability with Capacitive Load

Parameter	Conditions	Min	Typ	Max	Unit
Gain Margin					
A_V = +1, C_L = 10 pF	See Figure 5.	0.4	6.8	10	dB
A_V = +3/–2, C_L = 10000 pF	See Figure 9 for gain setting.	4.3	7	8.9	dB
Phase Margin					
A_V = +1, C_L = 10 pF	See Figure 5.	1.77	34	45	Degrees
A_V = +3/–2, C_L = 10000 pF	See Figure 9 for gain setting.	4.7	6.5	9.1	Degrees

Table 21. Dynamic Performance

Parameter	Conditions	Min	Typ	Max	Unit
Propagation Delay (50% input to 50% output)					
A_V = +1, 2 V peak to peak	See Figure 10.	0.4	1	2	ns
A_V = +3, 6 V peak to peak*	See Figure 12.	2.4	4	8.6	ns
Rise/Fall Times (10% to 90%)					
A_V = +1, 2 V peak to peak	See Figure 10.	3	4	4.5	ns
A_V = +3, 6 V peak to peak*	See Figure 12.	6.6	9.8	17.4	ns
Overshoot Rising					
A_V = +1, 2 V peak to peak	See Figure 10.	4	10	28	%
A_V = +3, 6 V peak to peak*	See Figure 12.	4.1	4.5	5.4	%
Overshoot Falling					
A_V = +1, 2 V peak to peak	See Figure 10.	0	4	6	%
A_V = +3, 6 V peak to peak*	See Figure 12.	0	0	0	%
Settling Time (less than 0.1%)					
A_V = +1, 2 V peak to peak	See Figure 10.	—	10	—	ns
A_V = +3, 6 V peak to peak*	See Figure 12.	21	25	—	ns

* Input rise time = 1 ns.

Table 22. Operating Conditions

Parameter	Conditions	Min	Typ	Max	Unit
Operating Range					
Dual Supplies	—	±3	—	±6	V
Single Supply	—	5	—	12	V
Quiescent Current	V_{IN} = 0, A_V = +1, R_L = 10 kΩ.	14	17	20	mA

Electrical Characteristics

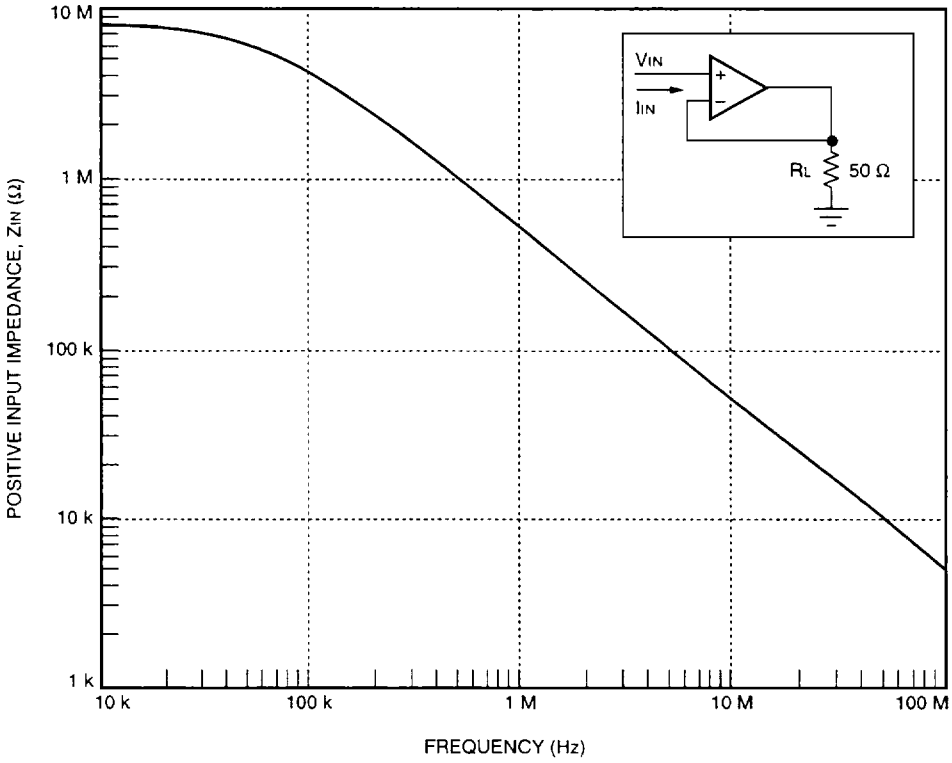


Figure 2. Input Impedance

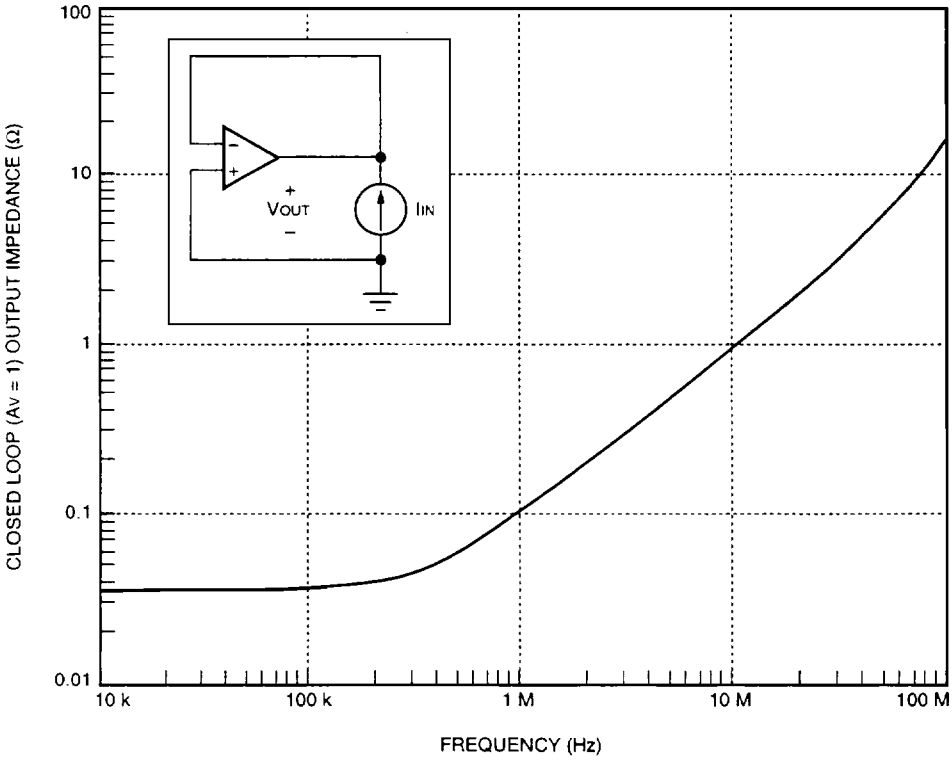
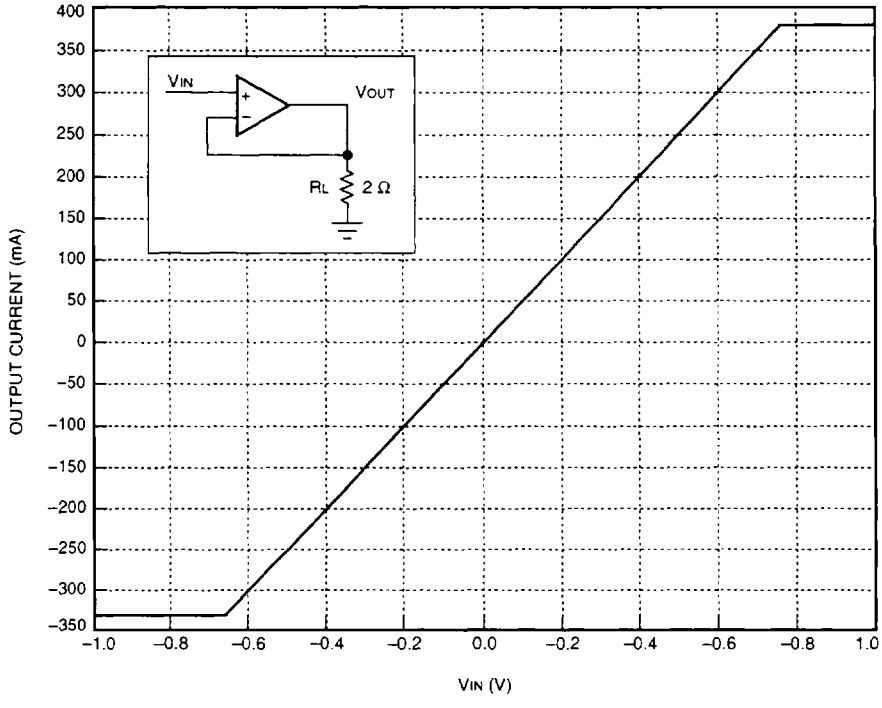


Figure 3. Closed Loop Output Impedance vs. Frequency

Electrical Characteristics (continued)



Note: Maximum current limited to ±210 mA by IC metallization.

Figure 4. Current Drive Capability

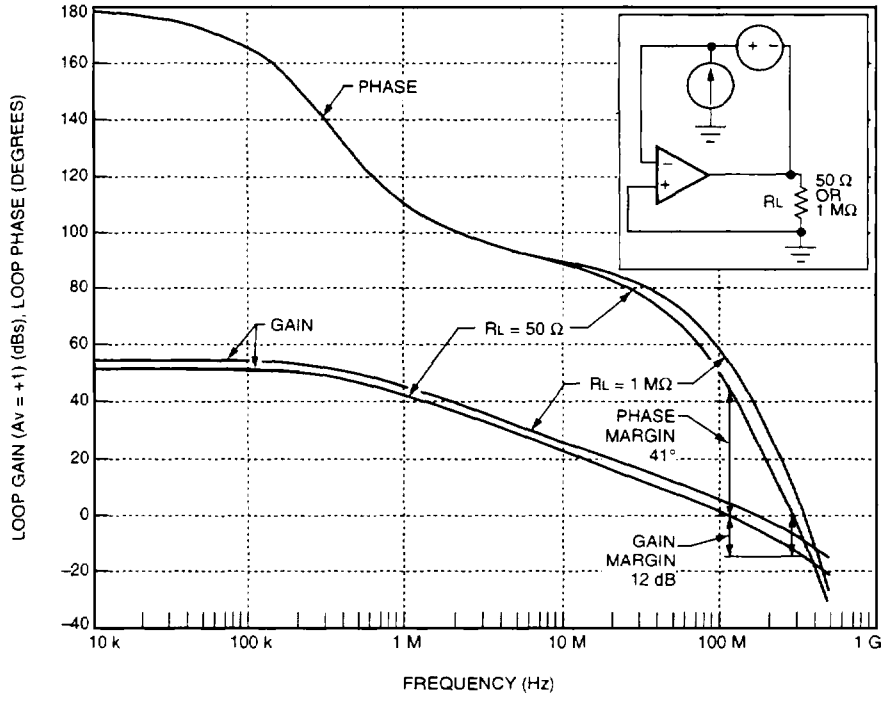


Figure 5. Unity Gain Stability (Middlebrook*) Phase and Gain Margins with 50 Ω (Tables 5, 12, and 19) and 1 MΩ Loads

* Middlebrook, R. A., "Measurements Of Loop Gain In Feedback Systems" *International Journal of Electronics*, Vol. 38, No. 4, 1975, p. 485—512.

Electrical Characteristics (continued)

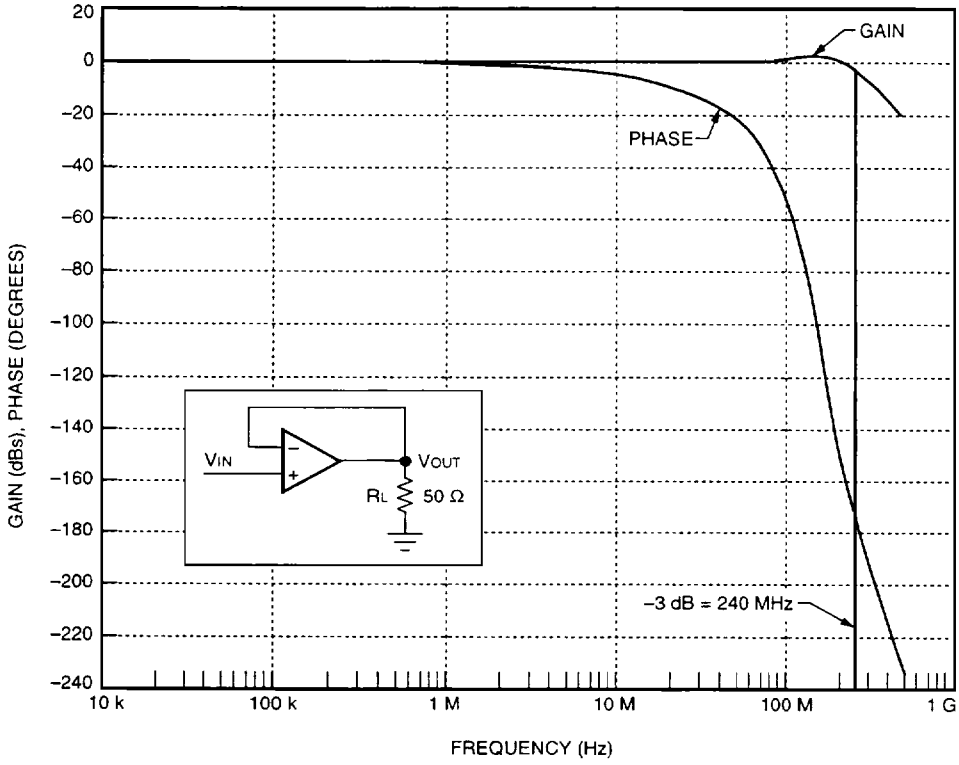


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Figure 6. Closed Loop Unity Gain (Av = +1) Bandwidth and Phase Shift

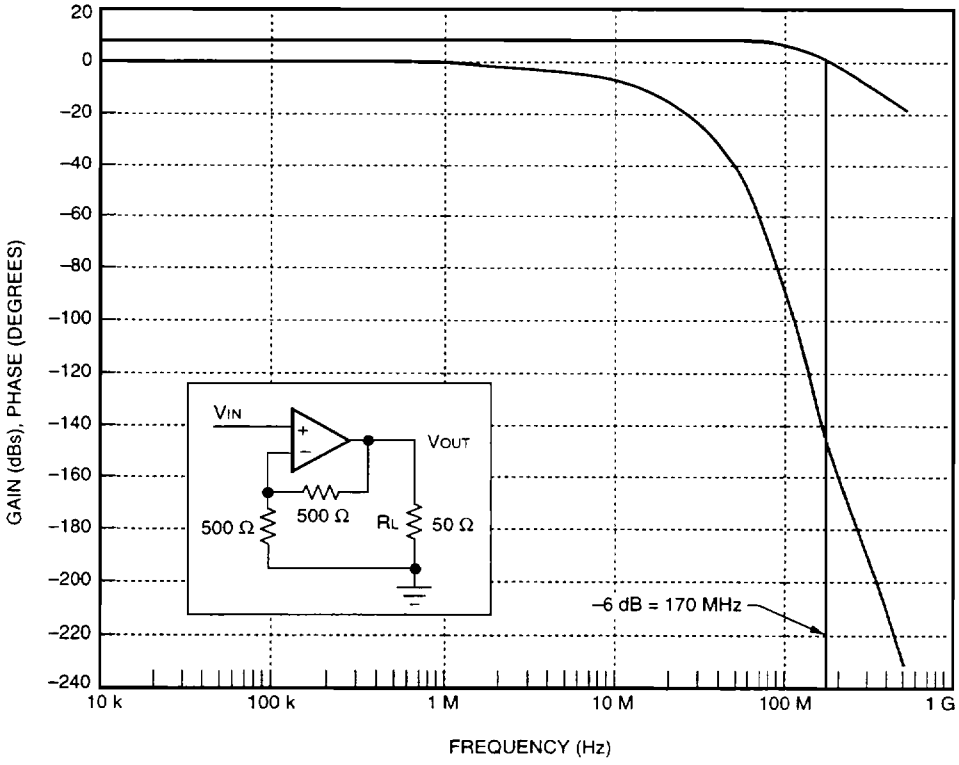

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Figure 7. Closed Loop (Av = +2) Bandwidth and Phase Shift (Gain Peak of 0.1 dB at 40 MHz)

Electrical Characteristics (continued)

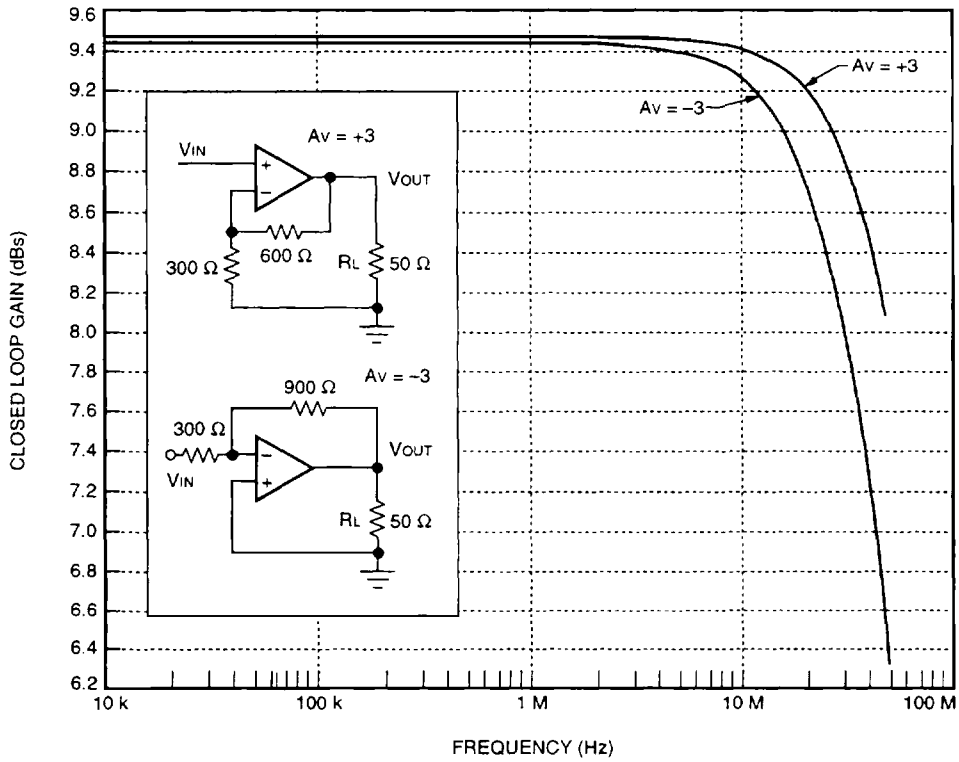

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Figure 8. Comparison of Av = +3 and Av = −3 Closed Loop Gain Indicating Matching Performance

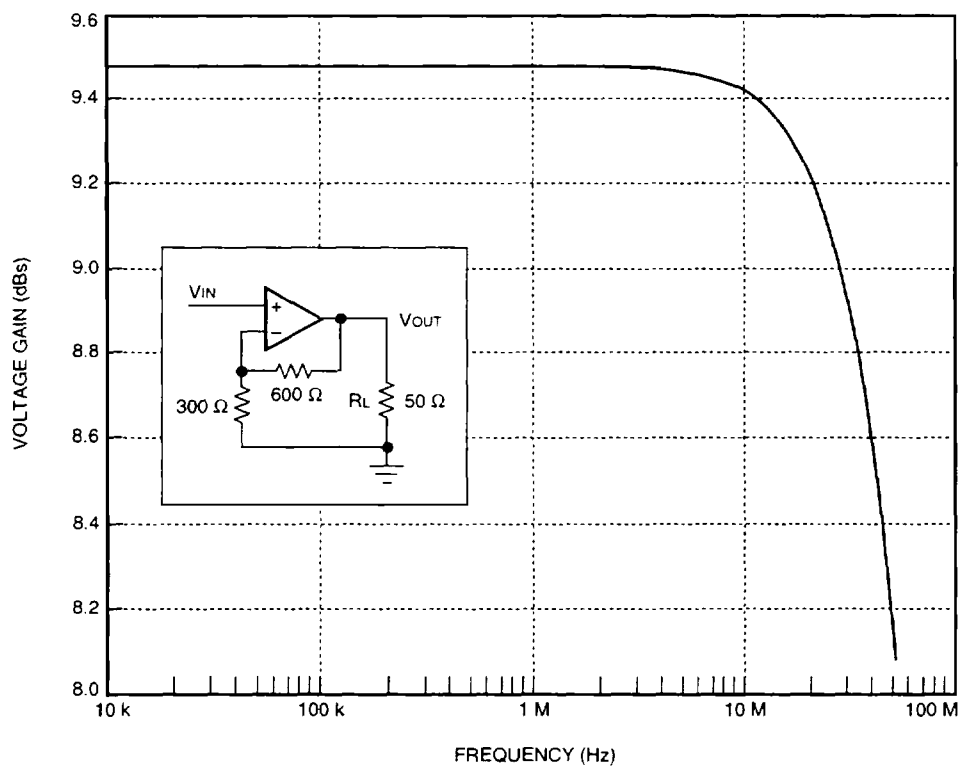

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Figure 9. Gain Flatness (Av = +3)

Electrical Characteristics (continued)

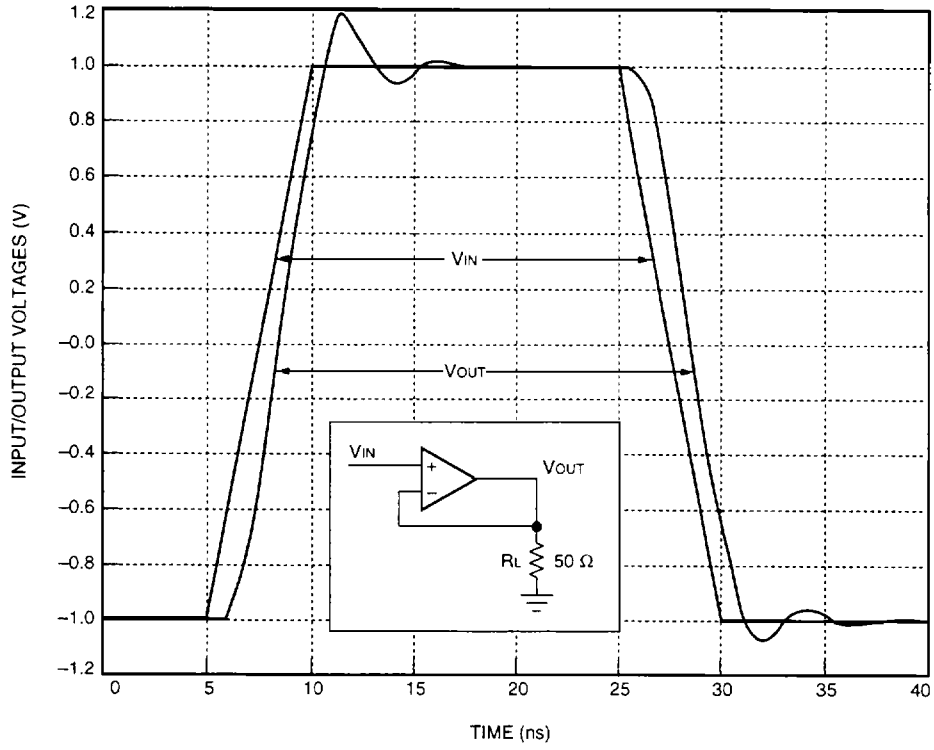


Figure 10. Pulse Response Illustrating Propagation Delay, Rise/Fall Times, and Under/Overshoot

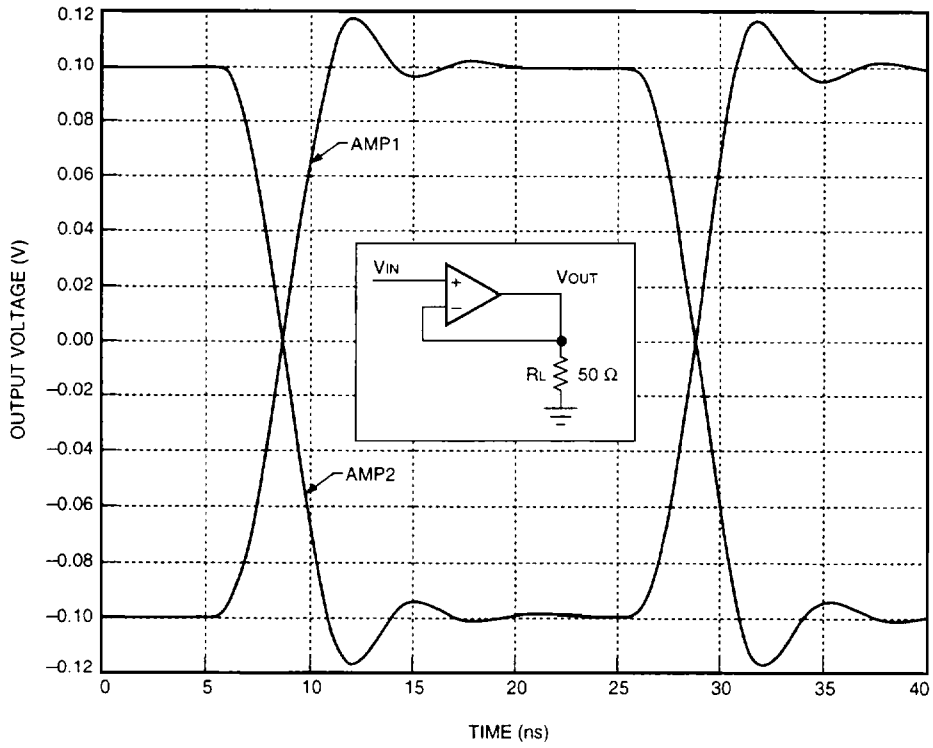


Figure 11. Unity Gain 100 mV Pulse Response Illustrating Propagation Delay, Rise/Fall Times, and Under/Overshoot for Amplifier 1 and 2

Electrical Characteristics (continued)

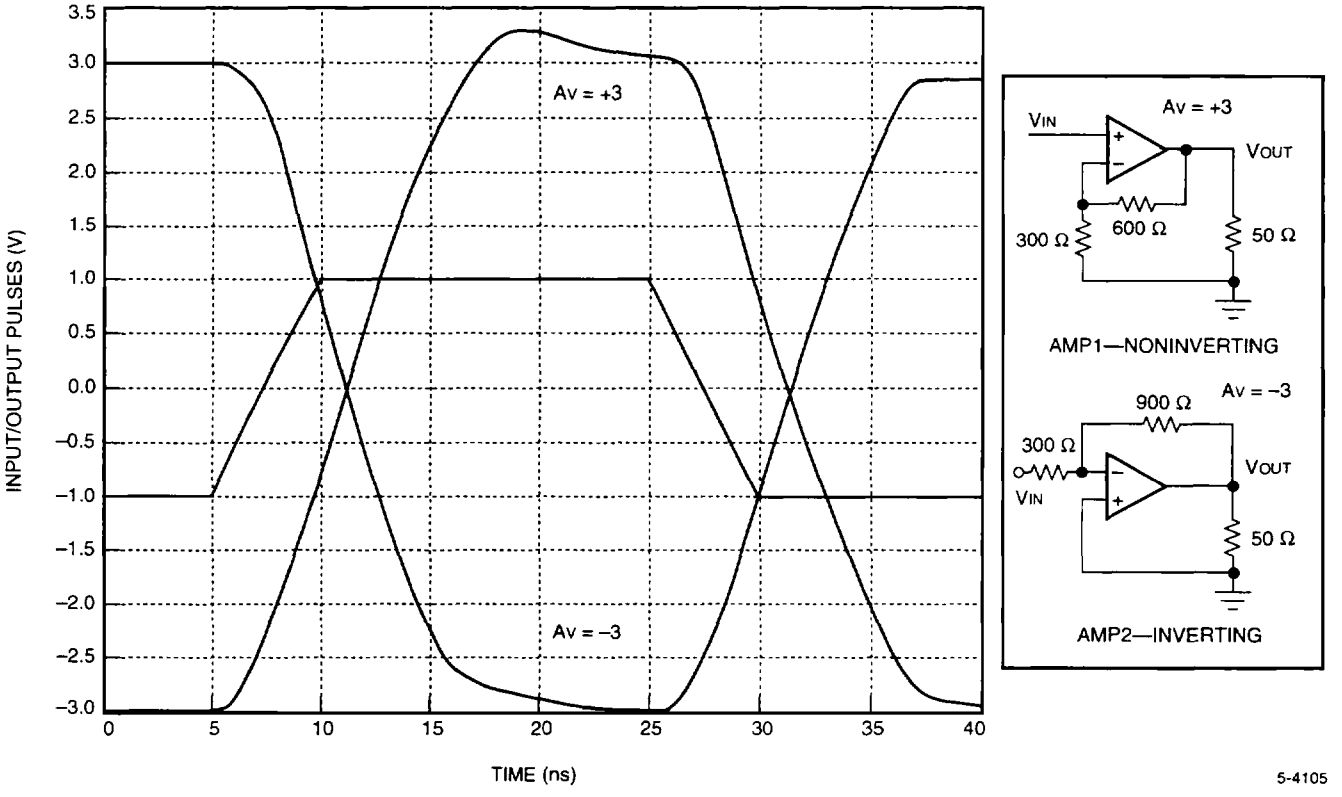


Figure 12. Inverting and Noninverting (Av = +3) Pulse Response Illustrating Slew-Rate Propagation Delay, Rise/Fall Times, and Under/Overshoot Matching

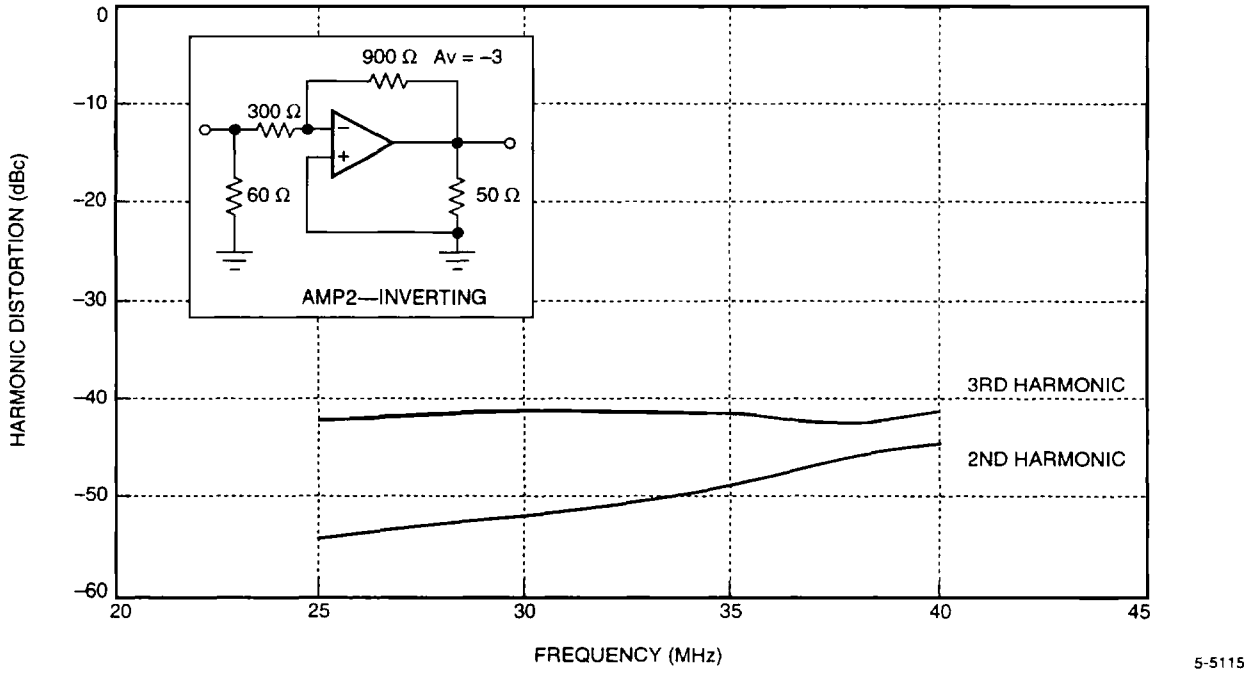


Figure 13. Harmonic Distortion for Av = –3; Pin = +10.5 dBm

Electrical Characteristics (continued)

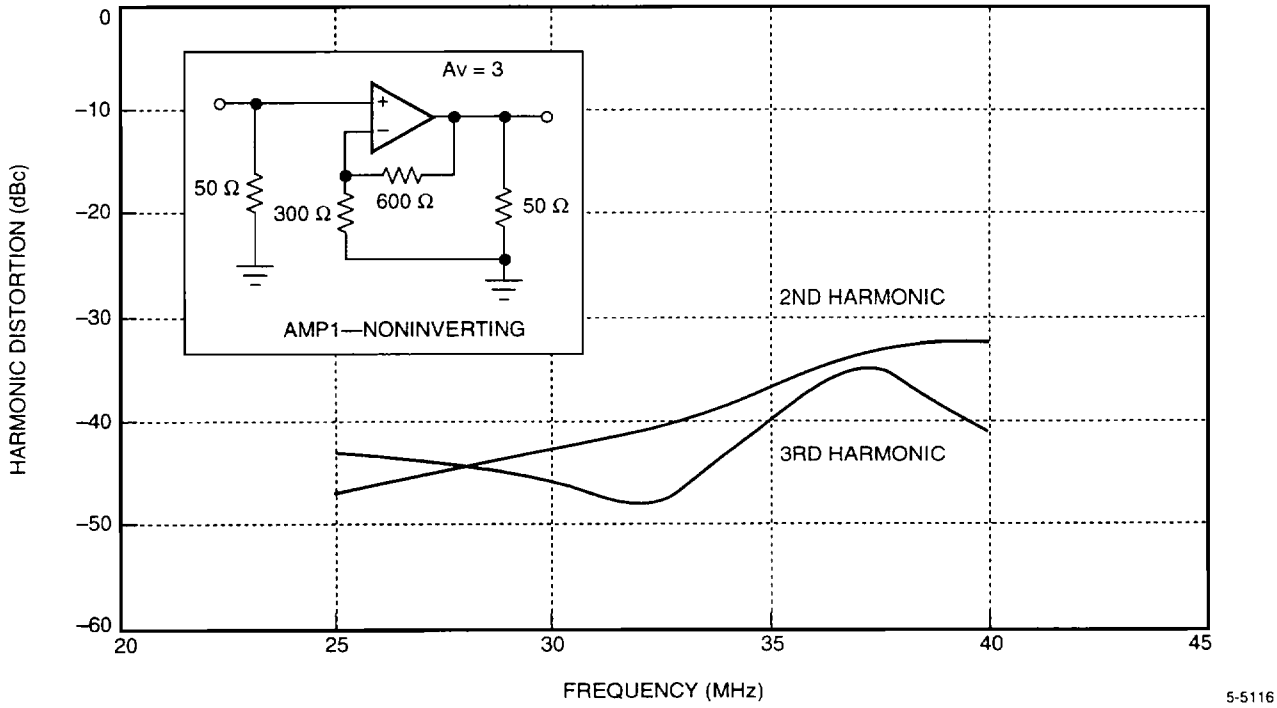


Figure 14. Harmonic Distortion for Av = +3; Pin = +10.5 dBm

Application

The LUCV5002 consists of two amplifiers. An external 22 Ω resistor at each output defines the output drive current. A 1:1.5 pulse transformer blocks common-mode signals and couples the desired differential signal onto the unshielded twisted pair. The driven end of the unshielded twisted pair is terminated by a 100 Ω resistor to match the characteristic impedance of the line. Figure 15 shows a typical configuration for the LUCV5002 in driving unshielded twisted pair. Figure 16 shows a typical configuration for driving 50 Ω coax transmission lines. Figure 17 shows a typical configuration for driving two UTP lines.

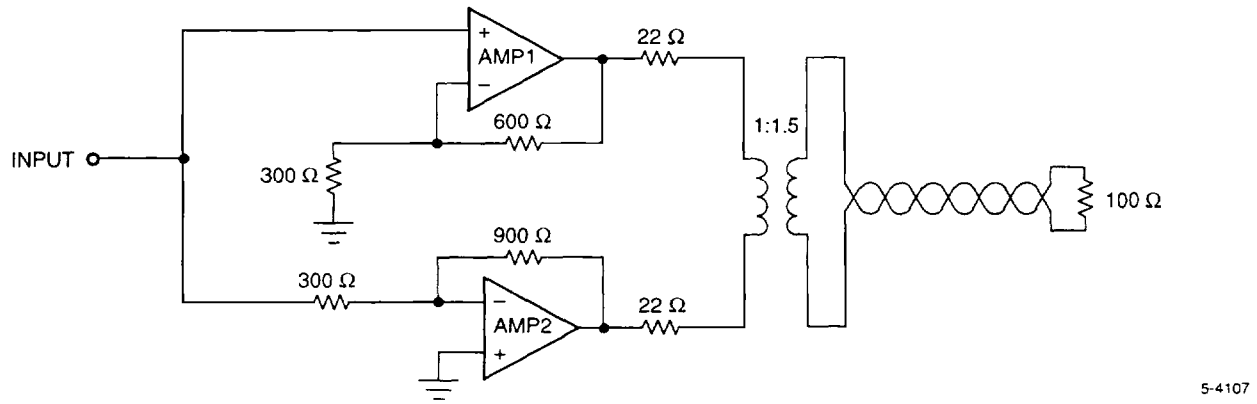


Figure 15. Typical Application for the LUCV5002

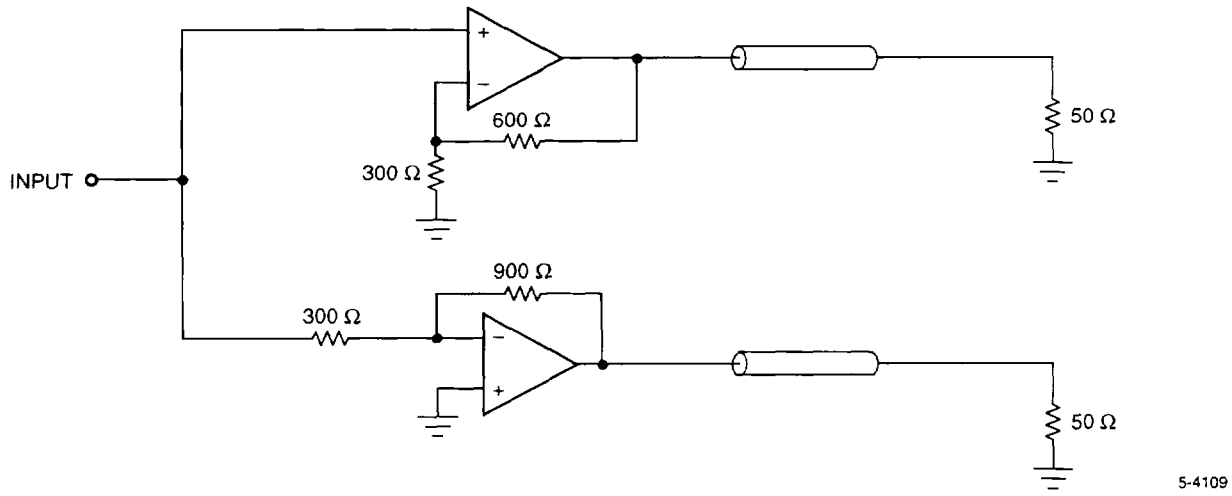


Figure 16. 50 Ω Coax Driver

Application (continued)

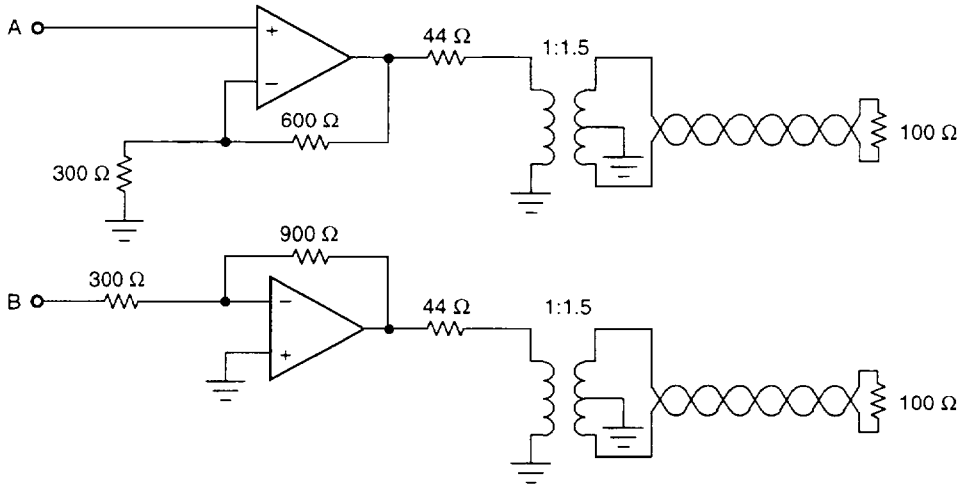


Figure 17. Driving Two UTP Lines

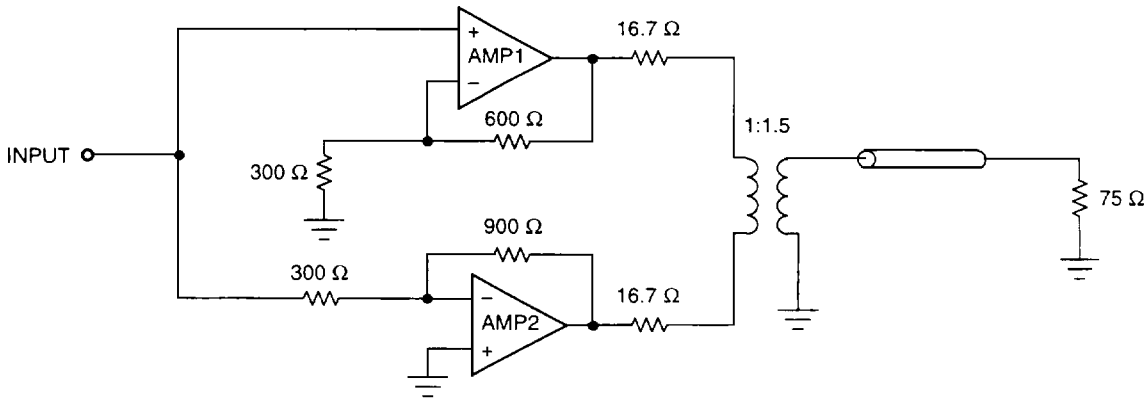
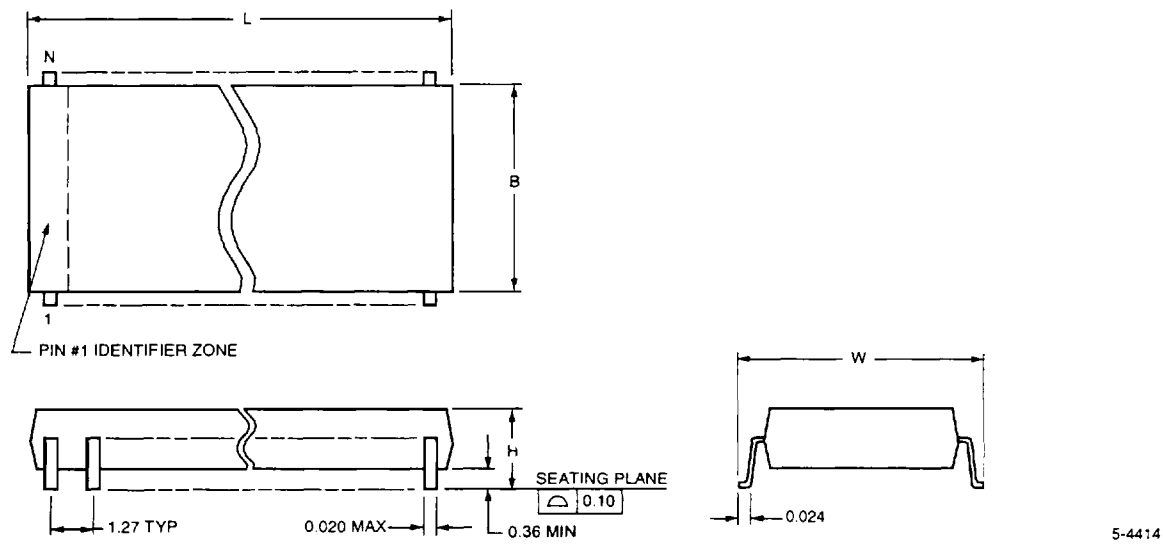


Figure 18. High-Power 75 Ω Coaxial Cable Driver

Outline Diagram

8-Pin SONB

Dimensions are in millimeters.



Package Description	Number of Pins (N)	Package Dimensions			
		Maximum Length (L)	Maximum Width Without Leads (B)	Maximum Width Including Leads (W)	Maximum Height Above Board (H)
SONB (Small Outline, Narrow Body)	8	5.08	4.01	6.17	1.73

Ordering Information

Device Code	Package	Temperature	Comcode
LUCV5002AS (Bulk)	8-pin SONB	–40 °C to +85 °C	107410326
LUCV5002AS-TR (Tape & Reel)	8-pin SONB	–40 °C to +85 °C	107602740

Notes

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