

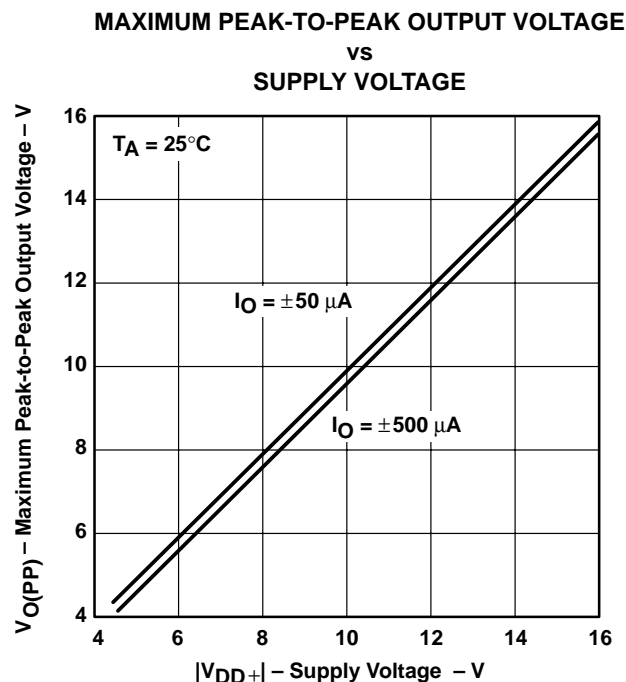
- Output Swing Includes Both Supply Rails
- Low Noise . . . 9 nV/√Hz Typ at f = 1 kHz
- Low Input Bias Current . . . 1 pA Typ
- Fully Specified for Both Single-Supply and Split-Supply Operation
- Common-Mode Input Voltage Range Includes Negative Rail
- High-Gain Bandwidth . . . 2.2 MHz Typ
- High Slew Rate . . . 3.6 V/μs Typ
- Low Input Offset Voltage
950 μV Max at T_A = 25°C
- Macromodel Included
- Performance Upgrades for the TS272, TS274, TLC272, and TLC274

description

The TLC2272 and TLC2274 are dual and quadruple operational amplifiers from Texas Instruments. Both devices exhibit rail-to-rail output performance for increased dynamic range in single- or split-supply applications. The TLC227x family offers 2 MHz of bandwidth and 3 V/μs of slew rate for higher speed applications. These devices offer comparable ac performance while having better noise, input offset voltage, and power dissipation than existing CMOS operational amplifiers. The TLC227x has a noise voltage of 9 nV/√Hz; two times lower than competitive solutions.

The TLC227x, exhibiting high input impedance and low noise, is excellent for small-signal conditioning for high-impedance sources, such as piezoelectric transducers. Because of the micro-power dissipation levels, these devices work well in hand-held monitoring and remote-sensing applications. In addition, the rail-to-rail output feature with single- or split-supplies makes this family a great choice when interfacing with analog-to-digital converters (ADCs). For precision applications, the TLC227xA family is available and has a maximum input offset voltage of 950 μV. This family is fully characterized at 5 V and ±5 V.

The TLC2272/4 also makes great upgrades to the TLC272/4 or TS272/4 in standard designs. They offer increased output dynamic range, lower noise voltage and lower input offset voltage. This enhanced feature set allows them to be used in a wider range of applications. For applications that require higher output drive and wider input voltage range, see TLV2432 and TLV2442 devices. If the design requires single amplifiers, please see the TLV2211/21/31 family. These devices are single rail-to-rail operational amplifiers in the SOT-23 package. Their small size and low power consumption, make them ideal for high density, battery-powered equipment.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

Advanced LinCMOS is a trademark of Texas Instruments Incorporated.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 1997, Texas Instruments Incorporated

TLC227x, TLC227xA, TLC227xY

Advanced LinCMOS™ RAIL-TO-RAIL OPERATIONAL AMPLIFIERS

SLOS190 – FEBRUARY 1997

TLC2272 AVAILABLE OPTIONS

T _A	V _{IO} max At 25°C	PACKAGED DEVICES			CHIP FORM§ (Y)
		SMALL OUTLINE† (D)	PLASTIC DIP (P)	TSSOP‡ (PW)	
0°C to 70°C	950 μV 2.5 mV	TLC2272ACD TLC2272CD	TLC2272ACP TLC2272CP	TLC2272CPWLE	TLC2272Y
-40°C to 85°C	950 μV 2.5 mV	TLC2272AID TLC2272ID	TLC2272AIP TLC2272IP	—	—
-55°C to 125°C	950 μV 2.5 mV	TLC2272AMD TLC2272MD	TLC2272AMP TLC2272MP	—	—

† The D packages are available taped and reeled. Add R suffix to the device type (e.g., TLC2272CDR).

‡ The PW package is available only left-end taped and reeled.

§ Chips are tested at 25°C.

TLC2274 AVAILABLE OPTIONS

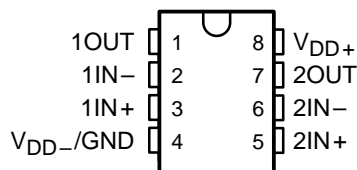
T _A	V _{IO} max AT 25°C	PACKAGED DEVICES					CHIP FORM§ (Y)
		SMALL OUTLINE† (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	TSSOP‡ (PW)	
0°C to 70°C	950 μV 2.5 mV	TLC2274ACD TLC2274CD	—	—	TLC2274ACN TLC2274CN	— TLC2274CPWLE	TLC2274Y
-40°C to 85°C	950 μV 2.5 mV	TLC2274AID TLC2274ID	—	—	TLC2274AIN TLC2274IN	— TLC2274IPWLE	—
-55°C to 125°C	950 μV 2.5 mV	TLC2274AMD TLC2274MD	TLC2274AMFK TLC2274MFK	TLC2274AMJ TLC2274MJ	TLC2274AMN TLC2274MN	—	—

† The D packages are available taped and reeled. Add R suffix to device type (e.g., TLC2274CDR).

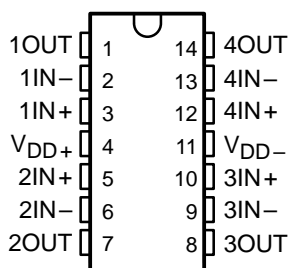
‡ The PW package is available only left-end taped and reeled.

§ Chips are tested at 25°C.

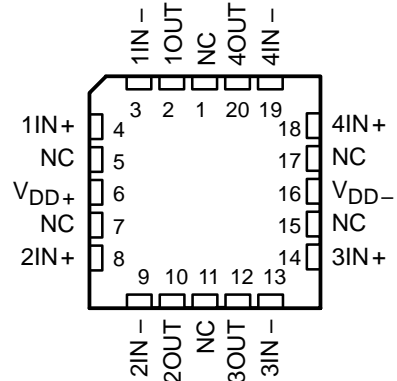
TLC2272
D, P, OR PW PACKAGE
(TOP VIEW)



TLC2274
D, J, N, OR PW PACKAGE
(TOP VIEW)



TLC2274
FK PACKAGE
(TOP VIEW)



NC – No internal connection

TLC227x, TLC227xA, TLC227xY
Advanced LinCMOS™ RAIL-TO-RAIL
OPERATIONAL AMPLIFIERS

SLOS190 – FEBRUARY 1997

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{DD+} (see Note 1)	8 V
Supply voltage, V_{DD-} (see Note 1)	-8 V
Differential input voltage, V_{ID} (see Note 2)	± 16 V
Input voltage, V_I (any input, see Note 1)	$V_{DD-} - 0.3$ V to V_{DD+}
Input current, I_I (any input)	± 5 mA
Output current, I_O	± 50 mA
Total current into V_{DD+}	± 50 mA
Total current out of V_{DD-}	± 50 mA
Duration of short-circuit current at (or below) 25°C (see Note 3)	unlimited
Continuous total dissipation	See Dissipation Rating Table
Operating free-air temperature range, T_A : C suffix	0°C to 70°C
I suffix	-40°C to 85°C
M suffix	-55°C to 125°C
Storage temperature range	-65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, N, P or PW package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: J package	300°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. All voltage values, except differential voltages, are with respect to the midpoint between V_{DD+} and V_{DD-} .
 2. Differential voltages are at $IN+$ with respect to $IN-$. Excessive current will flow if input is brought below $V_{DD-} - 0.3$ V.
 3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D-8	725 mW	5.8 mW/°C	464 mW	337 mW	145 mW
D-14	950 mW	7.6 mW/°C	608 mW	494 mW	190 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
J	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
N	1150 mW	9.2 mW/°C	736 mW	598 mW	230 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW	200 mW
PW-8	525 mW	4.2 mW/°C	336 mW	—	—
PW-14	700 mW	5.6 mW/°C	448 mW	364 mW	—

recommended operating conditions

	C SUFFIX		I SUFFIX		M SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{DD\pm}$	± 2.2	± 8	± 2.2	± 8	± 2.2	± 8	V
Input voltage range, V_I	V_{DD-}	$V_{DD+} - 1.5$	V_{DD-}	$V_{DD+} - 1.5$	V_{DD-}	$V_{DD+} - 1.5$	V
Common-mode input voltage, V_{IC}	V_{DD-}	$V_{DD+} - 1.5$	V_{DD-}	$V_{DD+} - 1.5$	V_{DD-}	$V_{DD+} - 1.5$	V
Operating free-air temperature, T_A	0	70	-40	85	-55	125	°C



TLC2274C electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A †	TLC2274C			TLC2274AC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage		25°C	300	2500		300	950	μV	
		Full range			3000		1500		
α_{VIO} Temperature coefficient of input offset voltage		25°C to 70°C	2			2			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)	$V_{DD\pm} = \pm 2.5\text{ V}$, $V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$	25°C	0.002			0.002			$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C	0.5			0.5			pA
		Full range	100			100			
I_{IB} Input bias current		25°C	1			1			pA
	Full range	100			100				
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$, $ V_{IO} \leq 5\text{ mV}$	25°C	0 to 4	-0.3 to 4.2		0 to 4	-0.3 to 4.2	V	
		Full range	0 to 3.5			0 to 3.5			
V_{OH} High-level output voltage	$I_{OH} = -20\ \mu\text{A}$	25°C	4.99			4.99			V
		Full range	4.85			4.85			
	$I_{OH} = -200\ \mu\text{A}$	25°C	4.85	4.93		4.85	4.93		
		Full range	4.25			4.25			
$I_{OH} = -1\text{ mA}$	25°C	4.25	4.65		4.25	4.65			
	Full range	4.25			4.25				
V_{OL} Low-level output voltage	$V_{IC} = 2.5\text{ V}$, $I_{OL} = 50\ \mu\text{A}$	25°C	0.01			0.01			V
		Full range	0.09			0.15			
	$V_{IC} = 2.5\text{ V}$, $I_{OL} = 500\ \mu\text{A}$	25°C	0.09			0.15			
		Full range	0.15			0.15			
$V_{IC} = 2.5\text{ V}$, $I_{OL} = 5\text{ mA}$	25°C	0.9	1.5		0.9	1.5			
	Full range	1.5			1.5				
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}$, $V_O = 1\text{ V to }4\text{ V}$	$R_L = 10\text{ k}\Omega$ ‡	25°C	15	35		15	35	V/mV
			Full range	15			15		
		$R_L = 1\text{ m}\Omega$ ‡	25°C	175			175		
r_{id} Differential input resistance		25°C	10^{12}			10^{12}			Ω
r_i Common-mode input resistance		25°C	10^{12}			10^{12}			Ω
c_i Common-mode input capacitance	$f = 10\text{ kHz}$, N package	25°C	8			8			pF
z_o Closed-loop output impedance	$f = 1\text{ MHz}$, $A_V = 10$	25°C	140			140			Ω
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }2.7\text{ V}$, $V_O = 2.5\text{ V}$, $R_S = 50\ \Omega$	25°C	70	75		70	75	dB	
		Full range	70			70			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	$V_{DD} = 4.4\text{ V to }16\text{ V}$, $V_{IC} = V_{DD}/2$, No load	25°C	80	95		80	95	dB	
		Full range	80			80			
I_{DD} Supply current	$V_O = 2.5\text{ V}$, No load	25°C	4.4	6		4.4	6	mA	
		Full range	6			6			

† Full range is 0°C to 70°C.

‡ Referenced to 2.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC227x, TLC227xA, TLC227xY
Advanced LinCMOS™ RAIL-TO-RAIL
OPERATIONAL AMPLIFIERS

SLOS190 – FEBRUARY 1997

TLC2274C operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

PARAMETER	TEST CONDITIONS		T_A †	TLC2274C			TLC2274AC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = 0.5\text{ V to }2.5\text{ V}$, $R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	2.3	3.6		2.3	3.6	V/ μ s	
			Full range	1.7			1.7			
V_n	Equivalent input noise voltage	$f = 10\text{ Hz}$ $f = 1\text{ kHz}$	25°C		50			50	nV/ $\sqrt{\text{Hz}}$	
			25°C		9			9		
$V_N(\text{PP})$	Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ to }1\text{ Hz}$ $f = 0.1\text{ to }10\text{ Hz}$	25°C		1			1	μ V	
			25°C		1.4			1.4		
I_n	Equivalent input noise current		25°C		0.6			0.6	fA/ $\sqrt{\text{Hz}}$	
THD + N	Total harmonic distortion plus noise	$V_O = 0.5\text{ V to }2.5\text{ V}$, $f = 20\text{ kHz}$, $R_L = 10\text{ k}\Omega$ ‡	25°C	$A_V = 1$		0.0013%		0.0013%		
				$A_V = 10$		0.004%		0.004%		
				$A_V = 100$		0.03%		0.03%		
	Gain-bandwidth product	$f = 10\text{ kHz}$, $C_L = 100\text{ pF}$ ‡	25°C		2.18			2.18	MHz	
BOM	Maximum output-swing bandwidth	$V_O(\text{PP}) = 2\text{ V}$, $R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C		1			1	MHz	
t_s	Settling time	$A_V = -1$, Step = 0.5 V to 2.5 V, $R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	To 0.1%		1.5		1.5	μ s	
				To 0.01%		2.6		2.6		
ϕ_m	Phase margin at unity gain	$R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C		50°			50°		
	Gain margin		25°C		10		10	dB		

† Full range is 0°C to 70°C.

‡ Referenced to 2.5 V



TYPICAL CHARACTERISTICS

EQUIVALENT INPUT NOISE VOLTAGE
 vs
 FREQUENCY

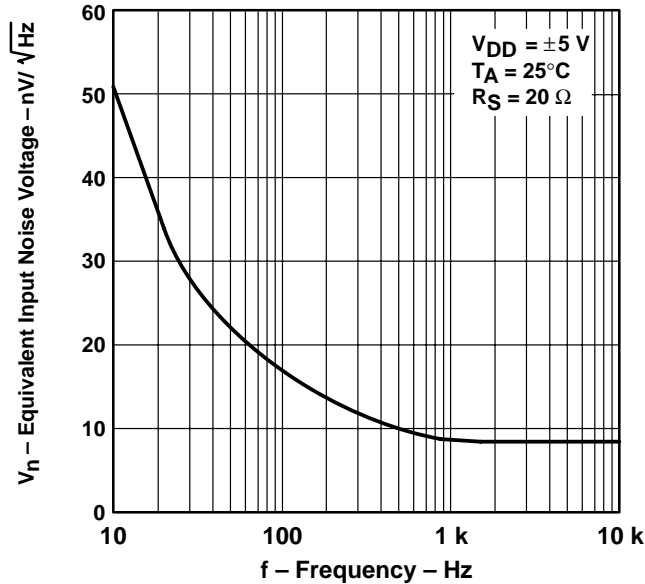


Figure 51

NOISE VOLTAGE
 OVER A 10 SECOND PERIOD

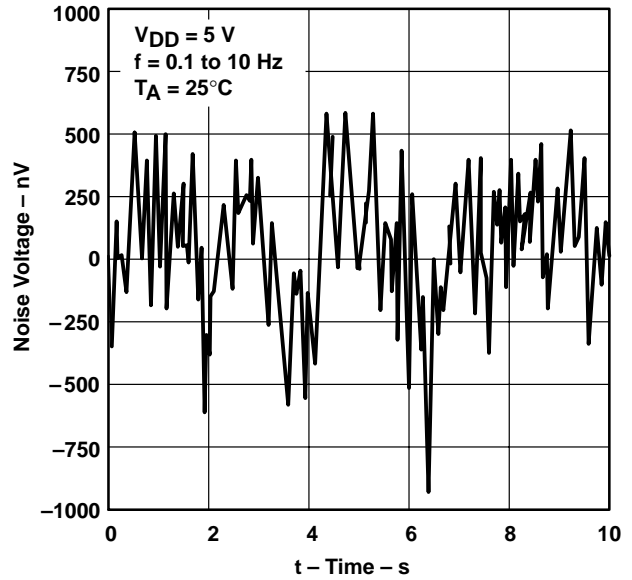


Figure 52

INTEGRATED NOISE VOLTAGE
 vs
 FREQUENCY

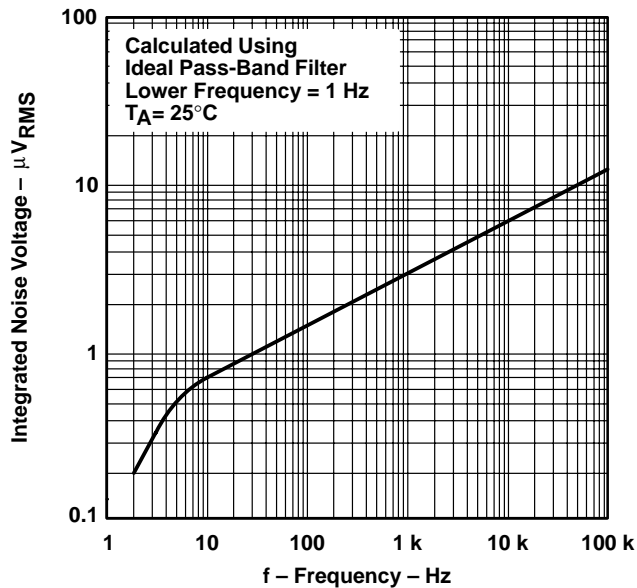


Figure 53

TOTAL HARMONIC DISTORTION PLUS NOISE
 vs
 FREQUENCY

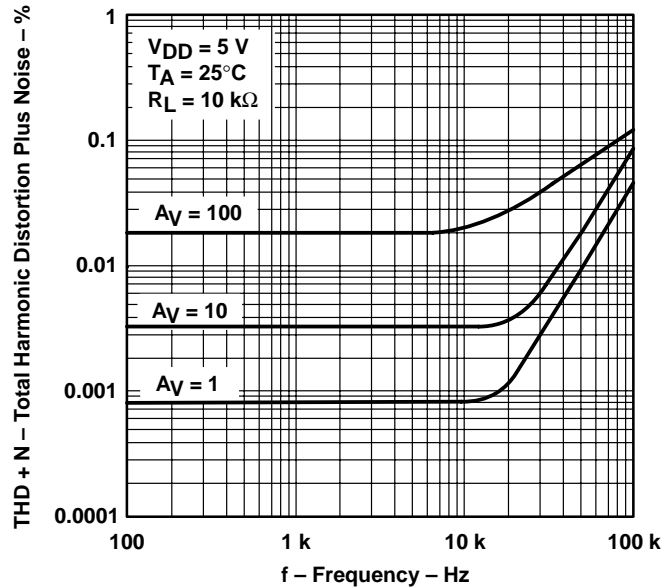


Figure 54

TYPICAL CHARACTERISTICS

GAIN-BANDWIDTH PRODUCT
 VS
 SUPPLY VOLTAGE

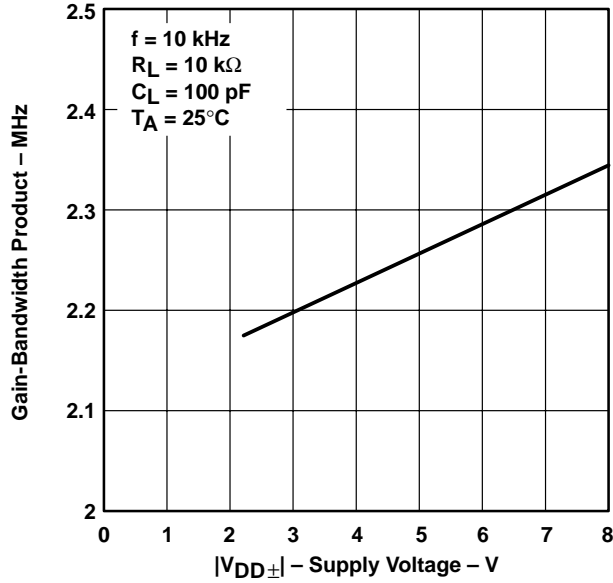


Figure 55

GAIN-BANDWIDTH PRODUCT†
 VS
 FREE-AIR TEMPERATURE

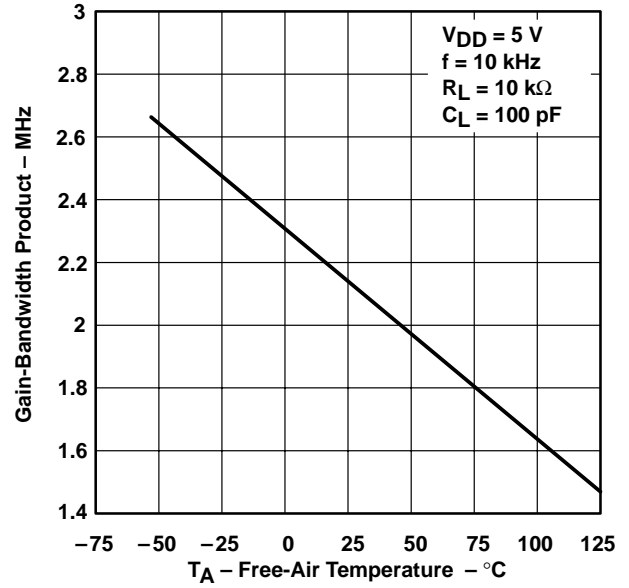


Figure 56

PHASE MARGIN
 VS
 LOAD CAPACITANCE

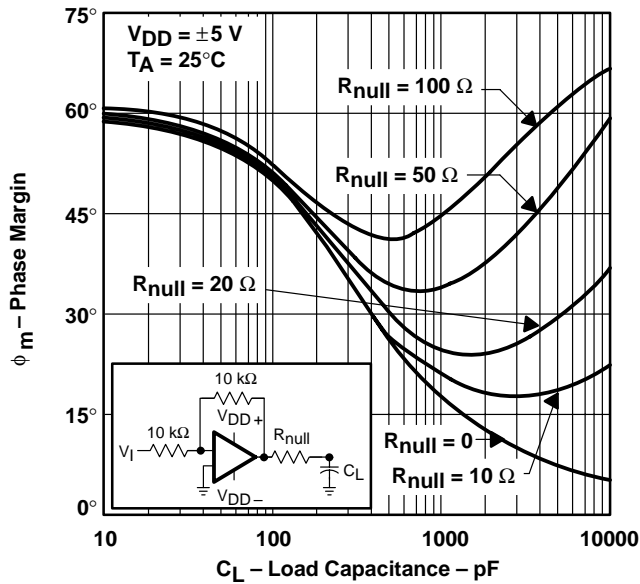


Figure 57

GAIN MARGIN
 VS
 LOAD CAPACITANCE

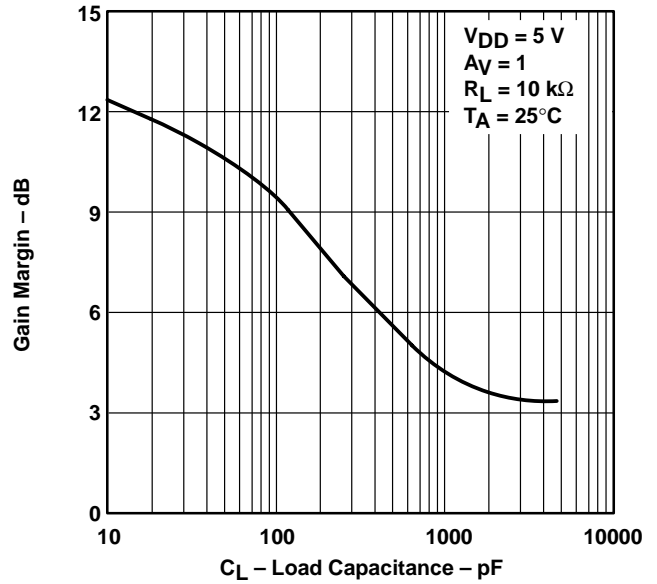


Figure 58

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.