

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

SLOS190E – FEBRUARY 1997 – REVISED MARCH 2001

- 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
- Available in Q-Temp Automotive HighRel Automotive Applications Configuration Control / Print Support Qualification to Automotive Standards

description

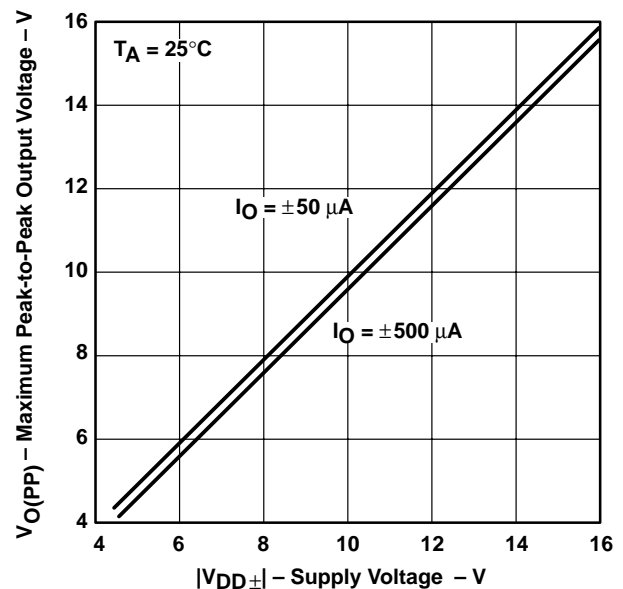
The TLC2272 and TLC2274 are dual and quadruple operational amplifiers from Texas Instruments. Both devices exhibit rail-to-rail output performance for increased dynamic range in single- or split-supply applications. The TLC227x family offers 2 MHz of bandwidth and 3 V/μs of slew rate for higher speed 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 the 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.

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
SUPPLY VOLTAGE



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.

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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**

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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

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TLC2272 AVAILABLE OPTIONS

T _A	V _{IO} max At 25°C	PACKAGED DEVICES		
		SMALL OUTLINE† (D)	PLASTIC DIP (P)	TSSOP‡ (PW)
0°C to 70°C	950 μV 2.5 mV	TLC2272ACD TLC2272CD	TLC2272ACP TLC2272CP	— TLC2272CPW
-40°C to 125°C	950 μV 2.5 mV	TLC2272AID TLC2272ID	TLC2272AIP TLC2272IP	— TLC2272IPW
	950 μV 2.5 mV	TLC2272AQD TLC2272QD	—	TLC2272AQPW TLC2272QPW
-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 taped and reeled. Add R suffix to the device type (e.g., TLC2272PWR).

§ Chips are tested at 25°C.

TLC2274 AVAILABLE OPTIONS

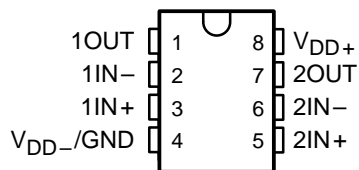
T _A	V _{IO} max AT 25°C	PACKAGED DEVICES				
		SMALL OUTLINE† (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	TSSOP‡ (PW)
0°C to 70°C	950 μV 2.5 mV	TLC2274ACD TLC2274CD	—	—	TLC2274ACN TLC2274CN	— TLC2274CPW
-40°C to 125°C	950 μV 2.5 mV	TLC2274AID TLC2274ID	—	—	TLC2274AIN TLC2274IN	— TLC2274IPW
	950 μV 2.5 mV	TLC2274AQD TLC2274QD	—	—	—	—
-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).

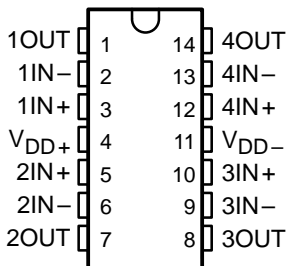
‡ The PW package is available taped and reeled.

§ Chips are tested at 25°C.

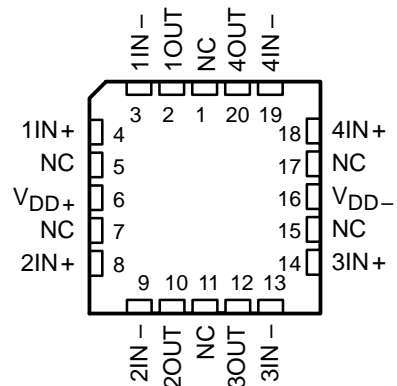
TLC2272
D, P, OR PW PACKAGE
(TOP VIEW)



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

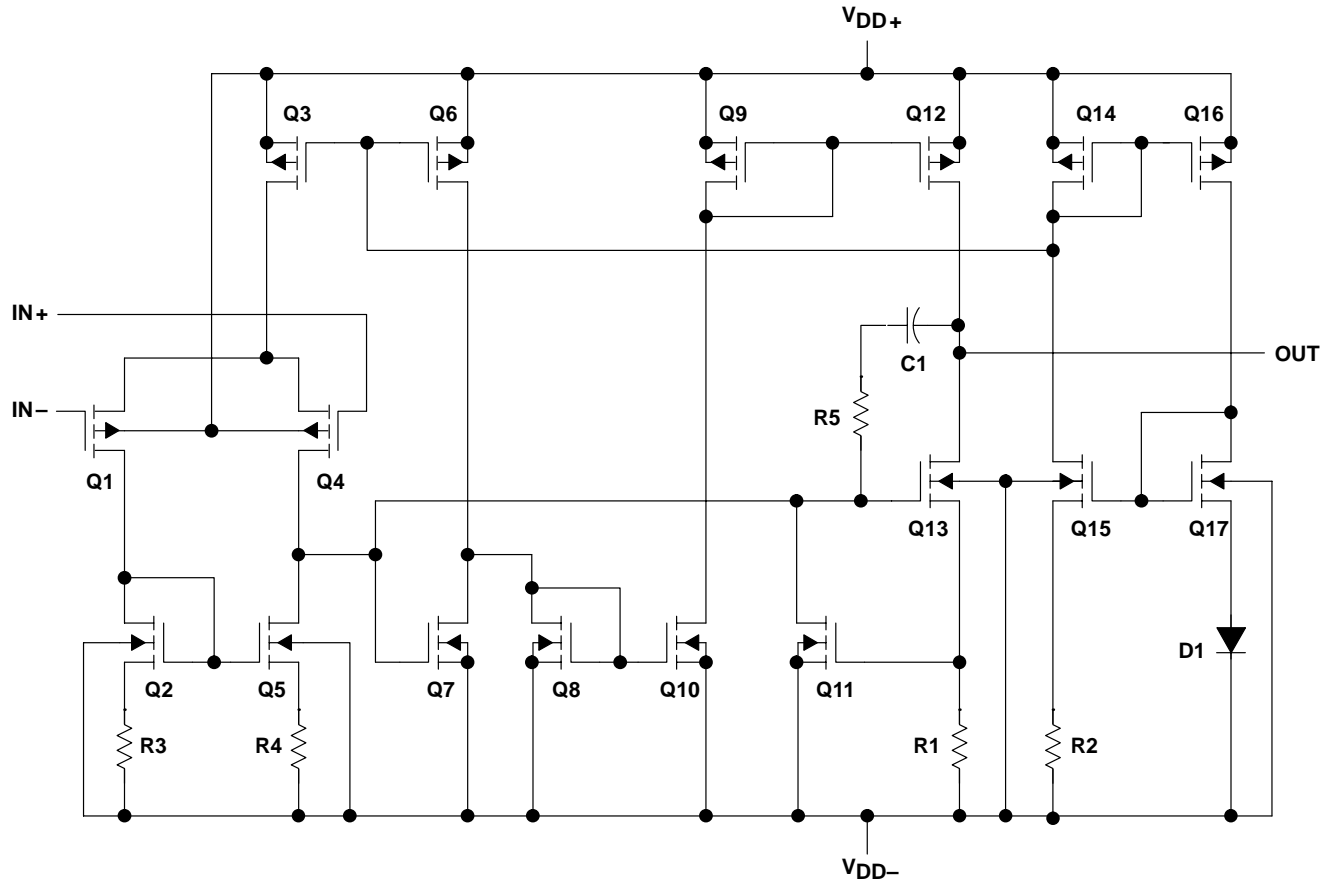


TLC2274
FK PACKAGE
(TOP VIEW)



NC – No internal connection

equivalent schematic (each amplifier)



ACTUAL DEVICE COMPONENT COUNT†		
COMPONENT	TLC2272	TLC2274
Transistors	38	76
Resistors	26	52
Diodes	9	18
Capacitors	3	6

† Includes both amplifiers and all ESD, bias, and trim circuitry

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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, Q suffix	-40°C to 125°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	273 mW	105 mW
PW-14	700 mW	5.6 mW/°C	448 mW	364 mW	—

recommended operating conditions

	C SUFFIX		I SUFFIX		Q SUFFIX		M SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{DD\pm}$	± 2.2	± 8	± 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_{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_{DD-}	$V_{DD+} - 1.5$	V
Operating free-air temperature, T_A	0	70	-40	125	-40	125	-55	125	°C



TYPICAL CHARACTERISTICS

**DISTRIBUTION OF TLC2272
 INPUT OFFSET VOLTAGE**

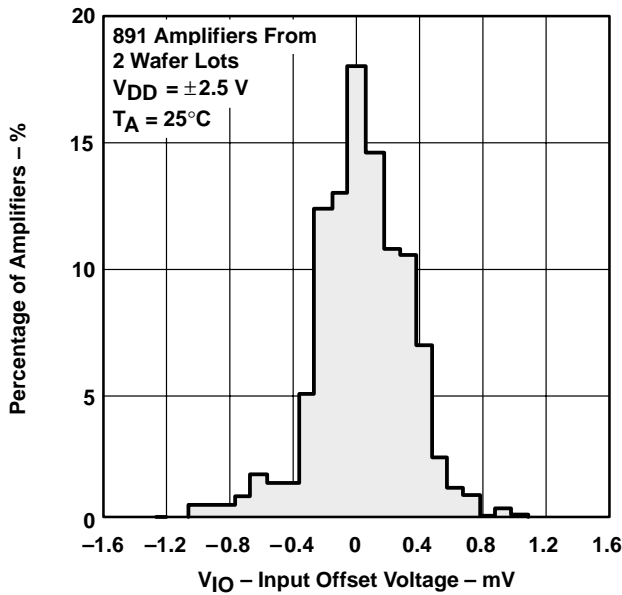


Figure 1

**DISTRIBUTION OF TLC2272
 INPUT OFFSET VOLTAGE**

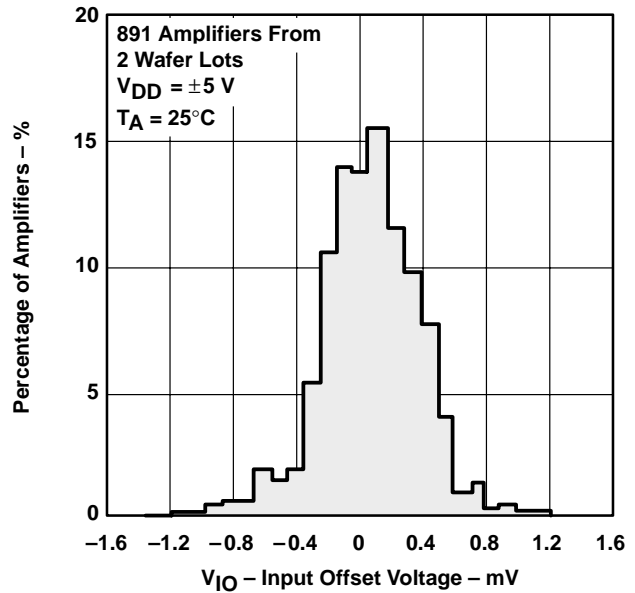


Figure 2

**DISTRIBUTION OF TLC2274
 INPUT OFFSET VOLTAGE**

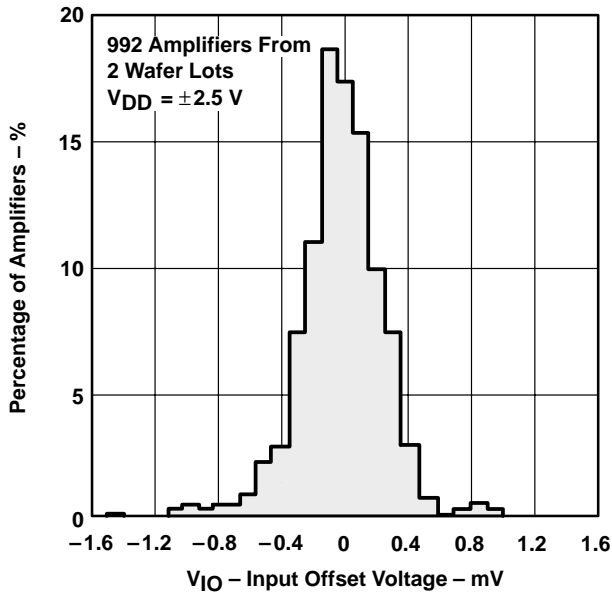


Figure 3

**DISTRIBUTION OF TLC2274
 INPUT OFFSET VOLTAGE**

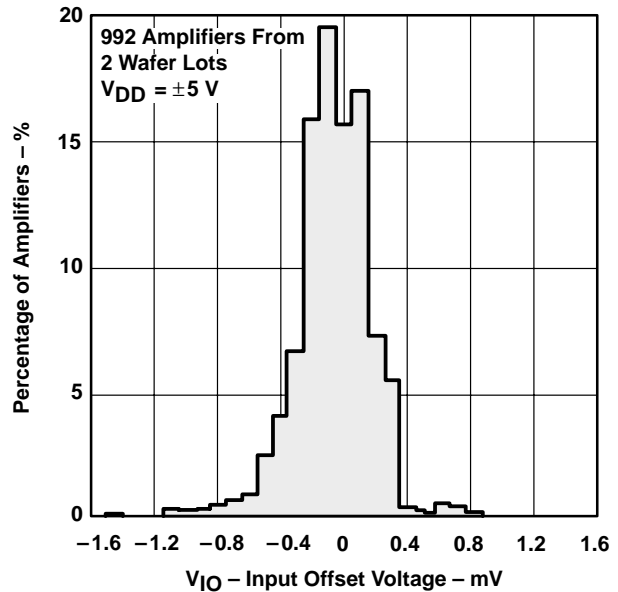


Figure 4

TYPICAL CHARACTERISTICS

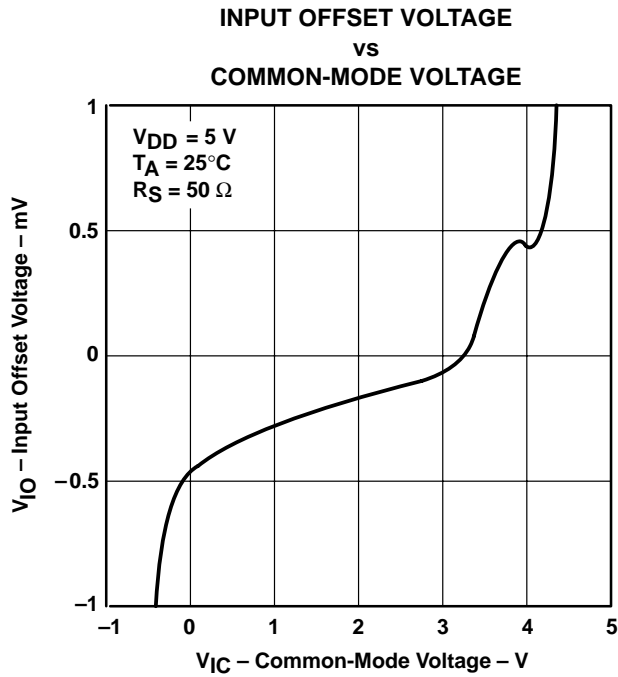


Figure 5

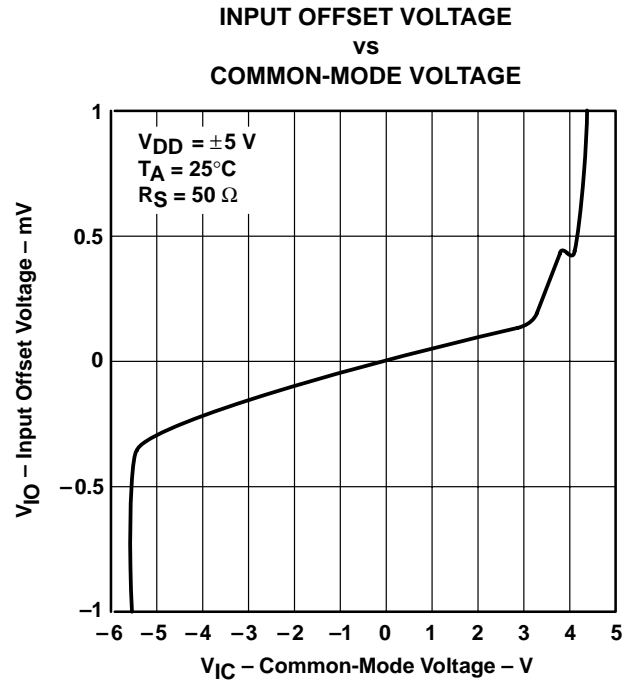


Figure 6

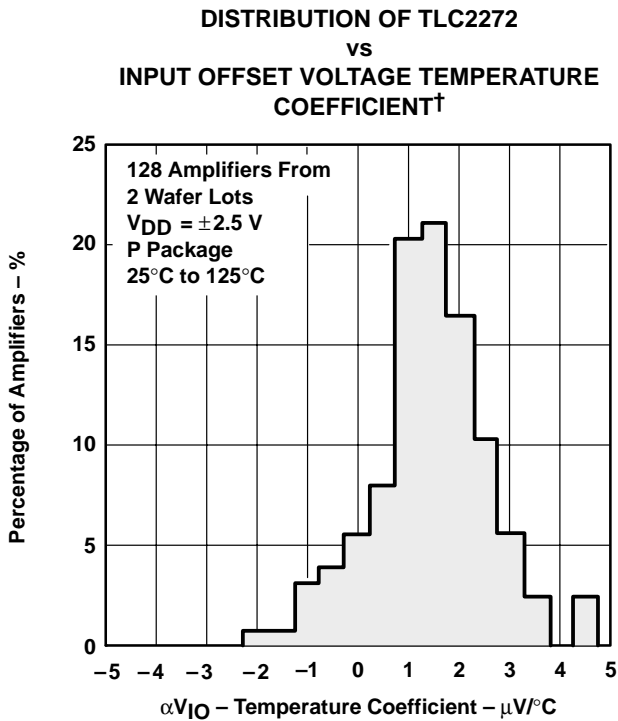


Figure 7

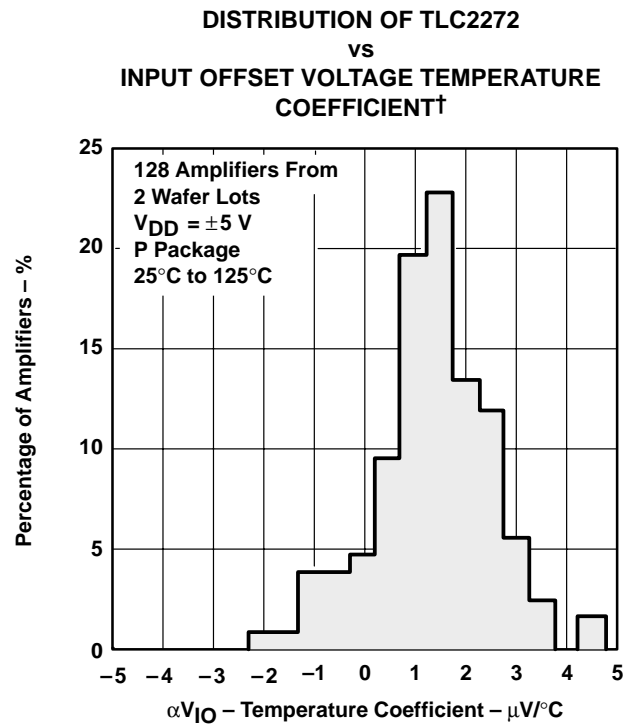


Figure 8

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

TYPICAL CHARACTERISTICS

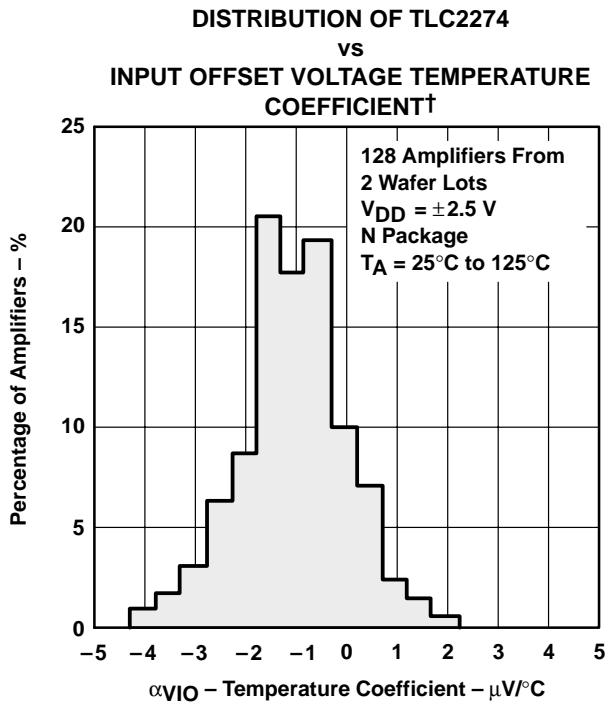


Figure 9

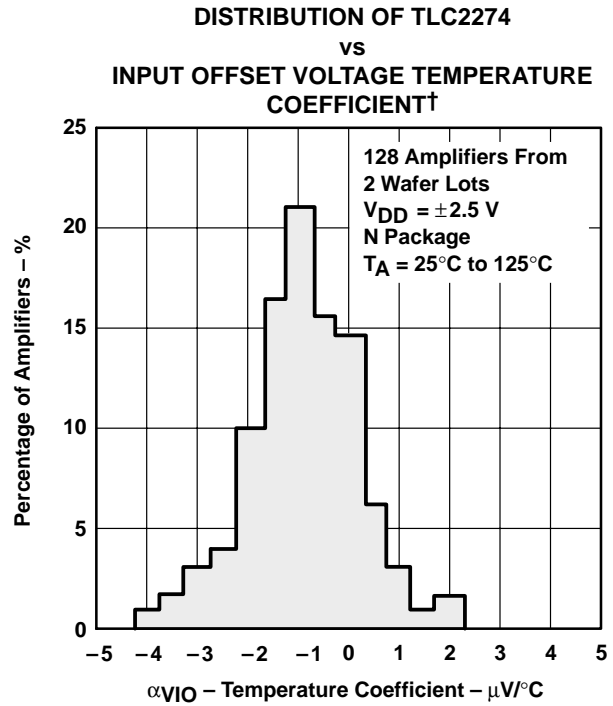


Figure 10

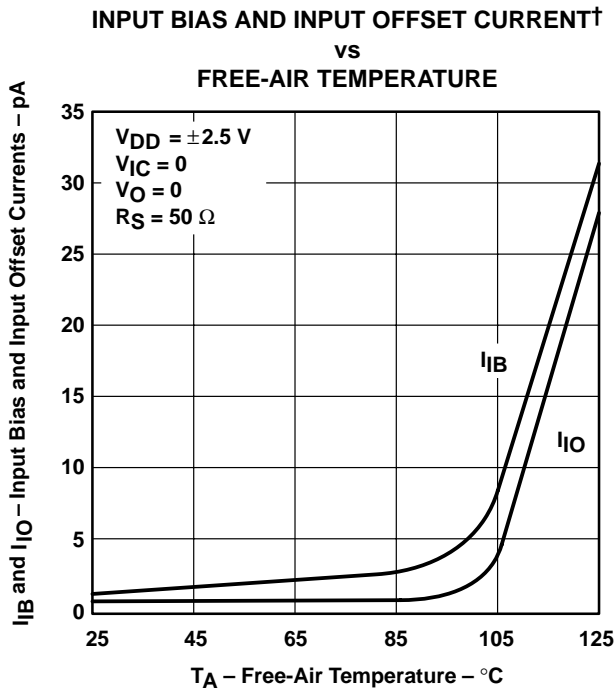


Figure 11

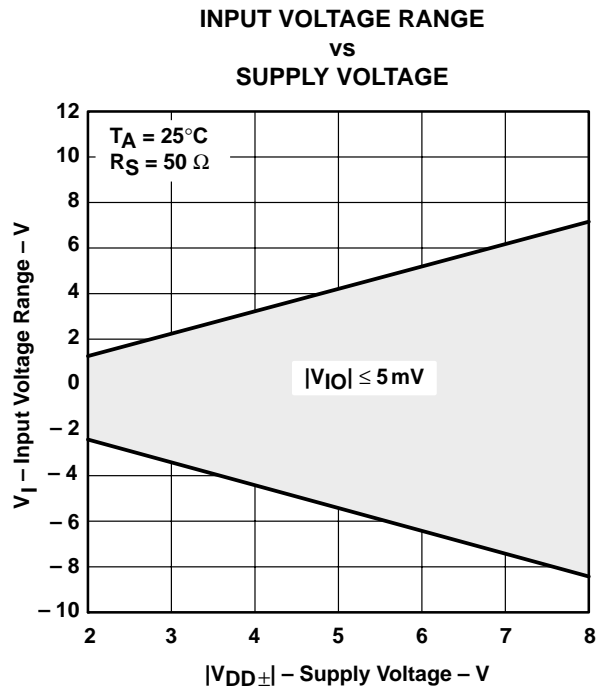


Figure 12

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

TYPICAL CHARACTERISTICS

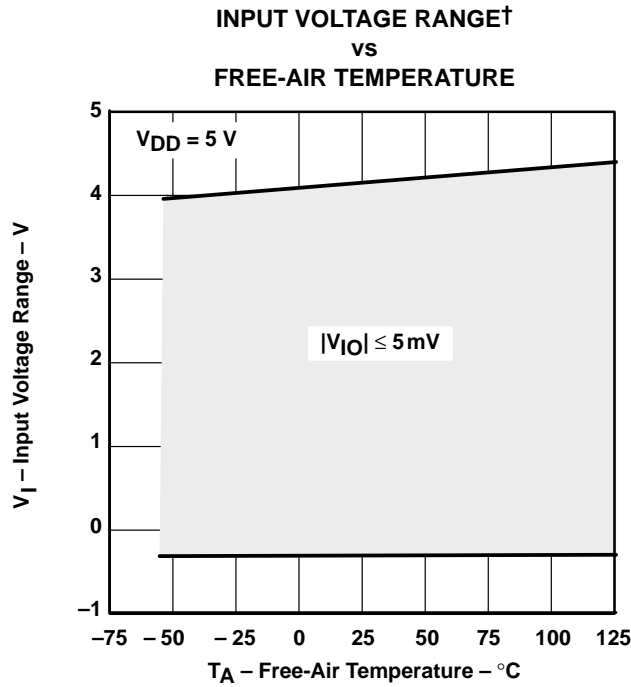


Figure 13

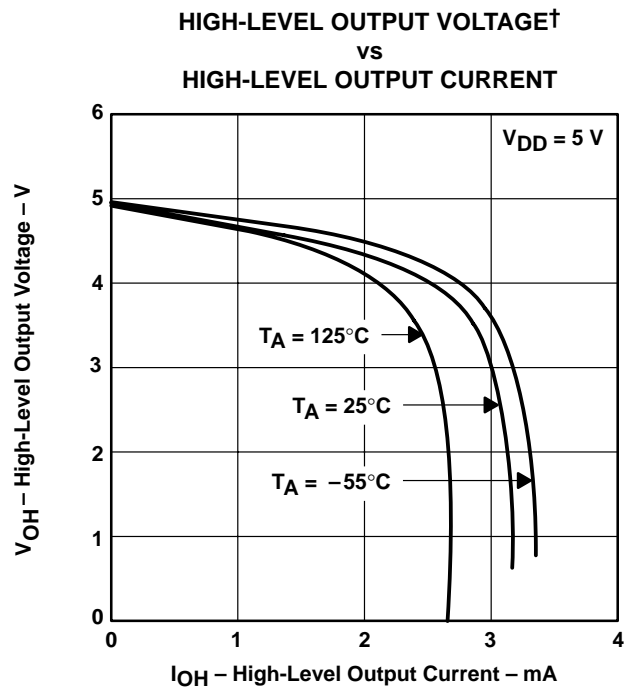


Figure 14

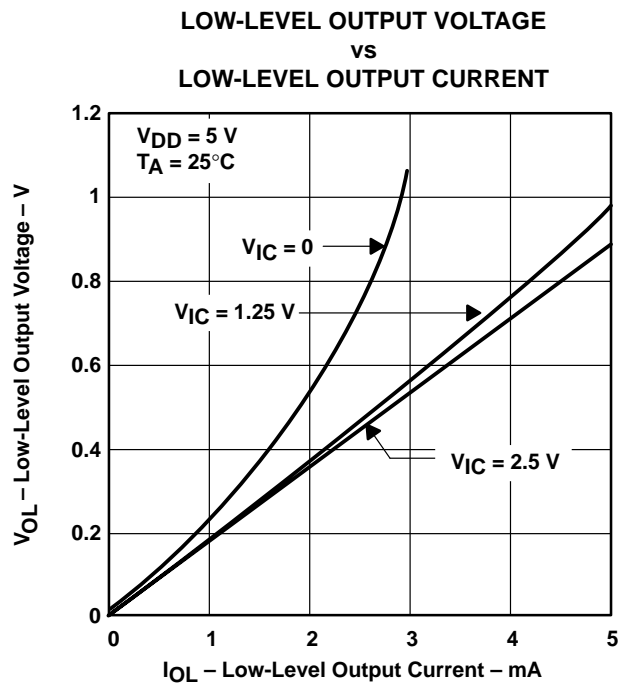


Figure 15

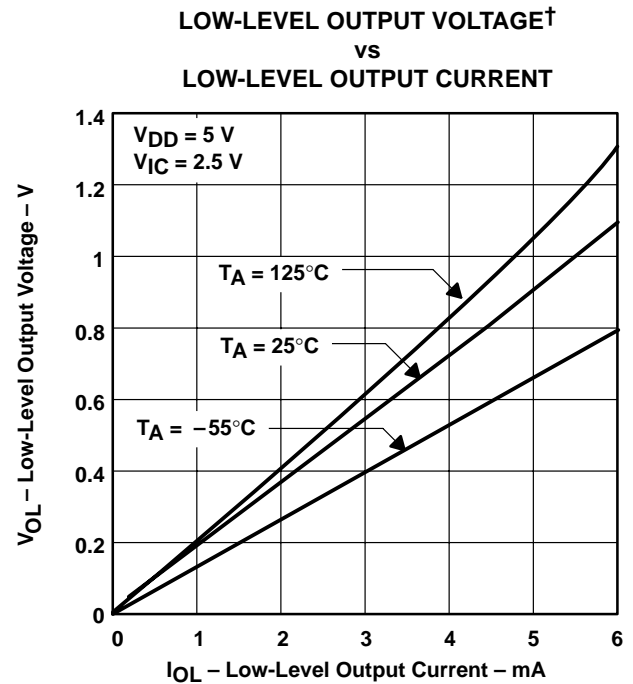


Figure 16

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

TYPICAL CHARACTERISTICS

MAXIMUM POSITIVE PEAK OUTPUT VOLTAGE†
vs
OUTPUT CURRENT

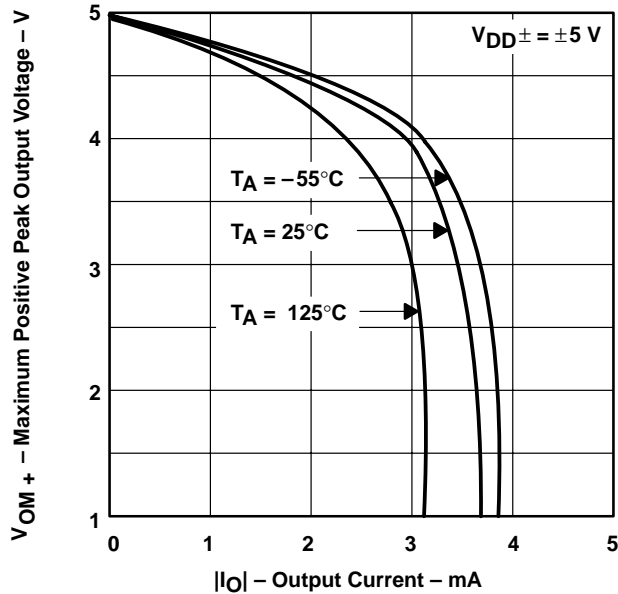


Figure 17

MAXIMUM NEGATIVE PEAK OUTPUT VOLTAGE†
vs
OUTPUT CURRENT

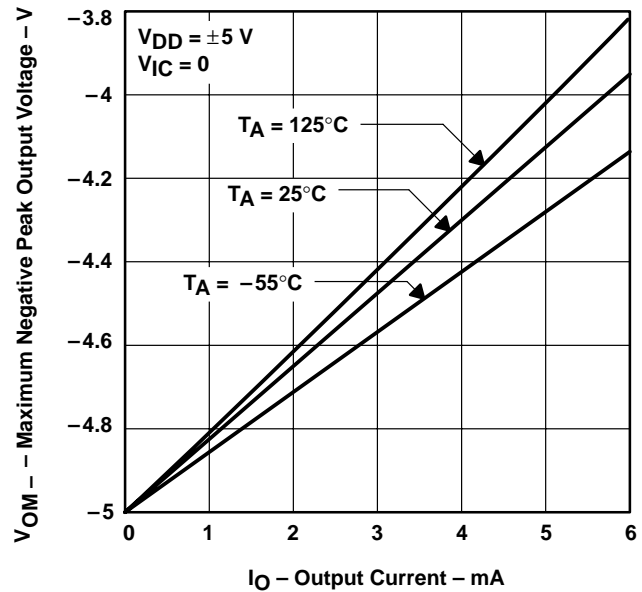


Figure 18

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY

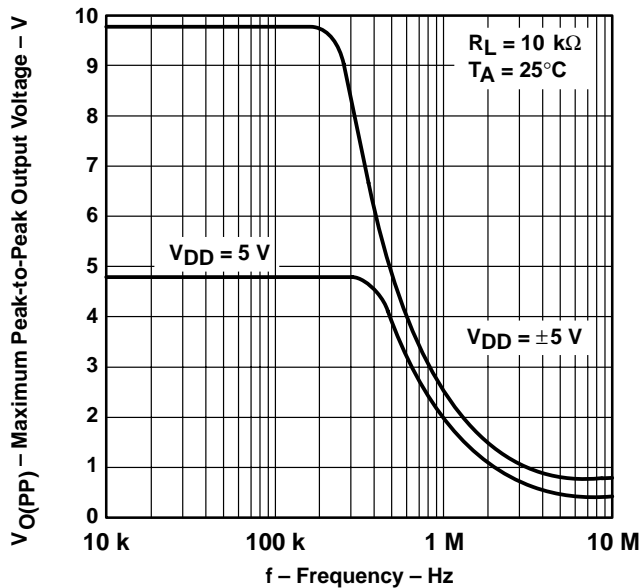


Figure 19

SHORT-CIRCUIT OUTPUT CURRENT
vs
SUPPLY VOLTAGE

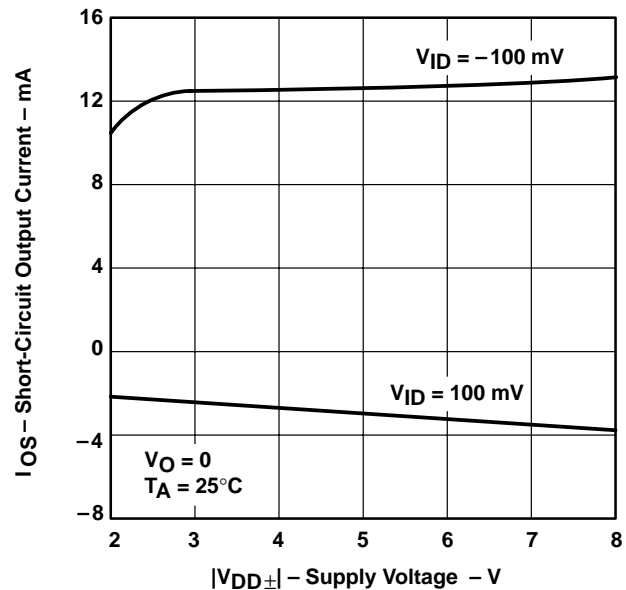


Figure 20

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

TYPICAL CHARACTERISTICS

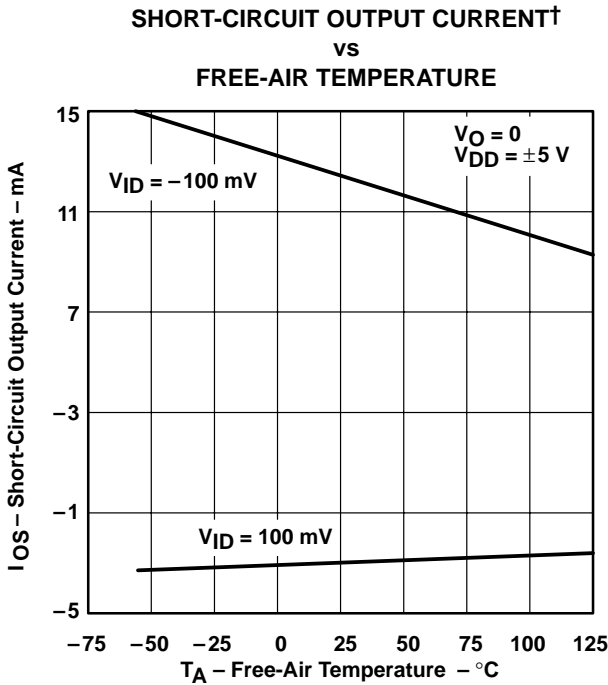


Figure 21

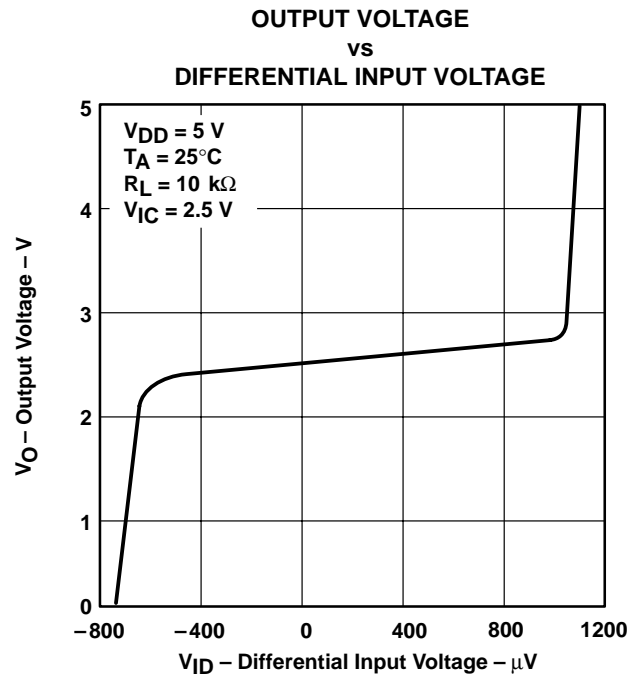


Figure 22

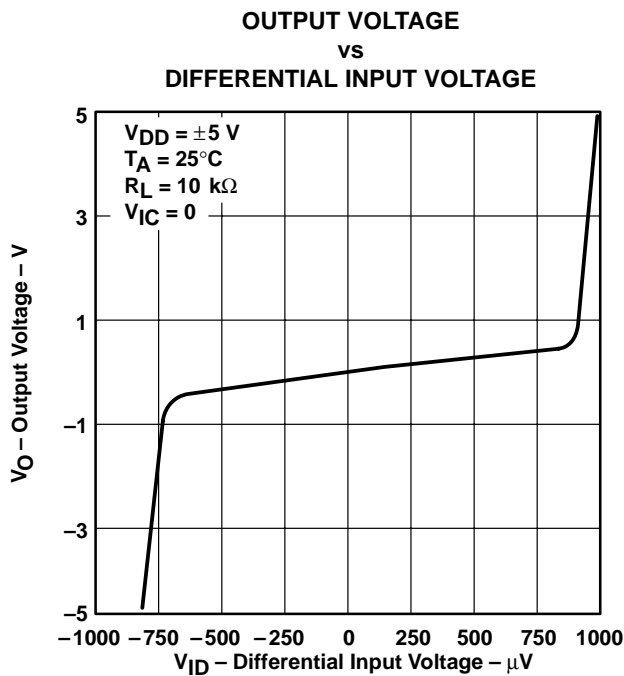


Figure 23

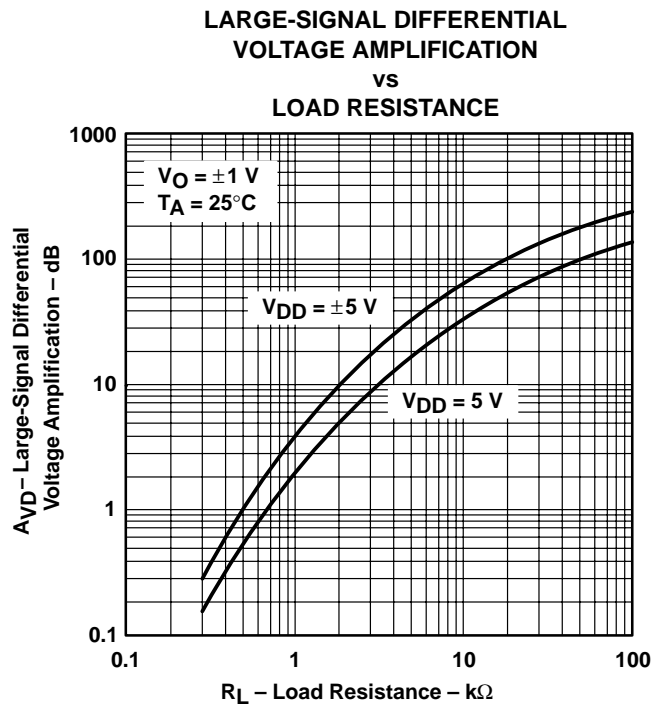


Figure 24

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

TYPICAL CHARACTERISTICS

LARGE-SIGNAL DIFFERENTIAL VOLTAGE
 AMPLIFICATION AND PHASE MARGIN

vs
 FREQUENCY

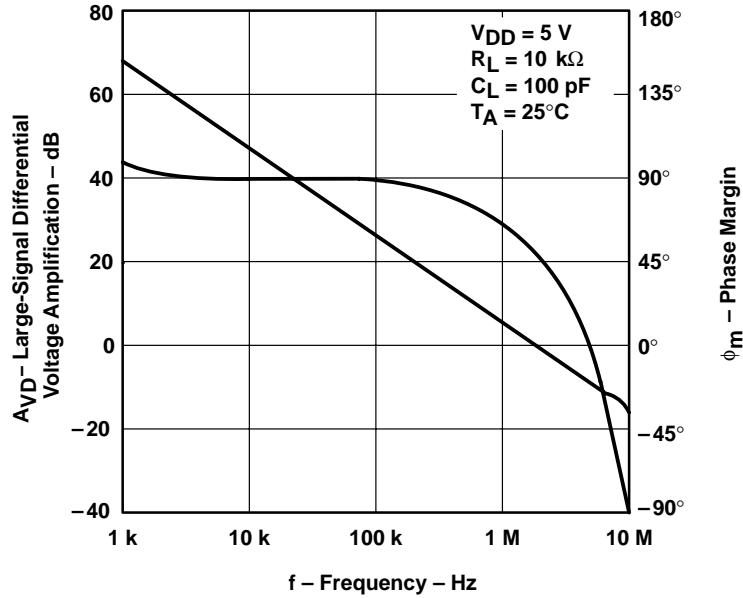


Figure 25

LARGE-SIGNAL DIFFERENTIAL VOLTAGE
 AMPLIFICATION AND PHASE MARGIN

vs
 FREQUENCY

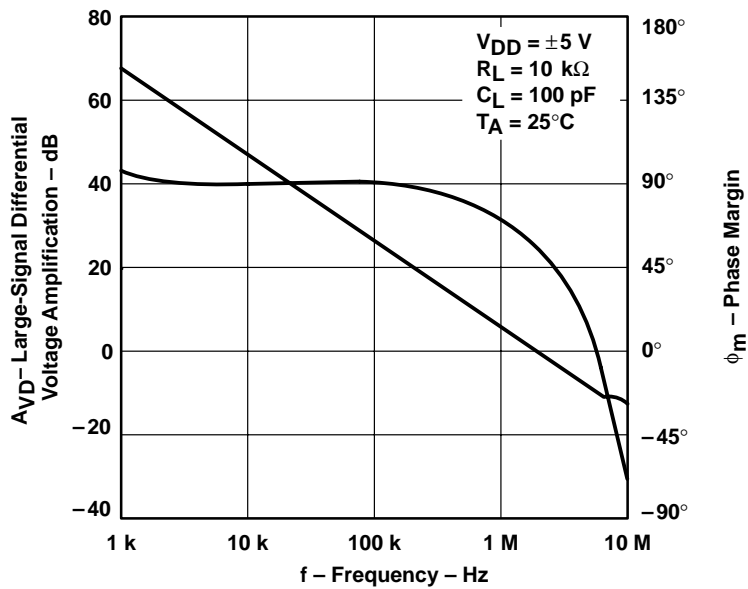


Figure 26

TYPICAL CHARACTERISTICS

LARGE-SIGNAL DIFFERENTIAL
 VOLTAGE AMPLIFICATION†
 vs
 FREE-AIR TEMPERATURE

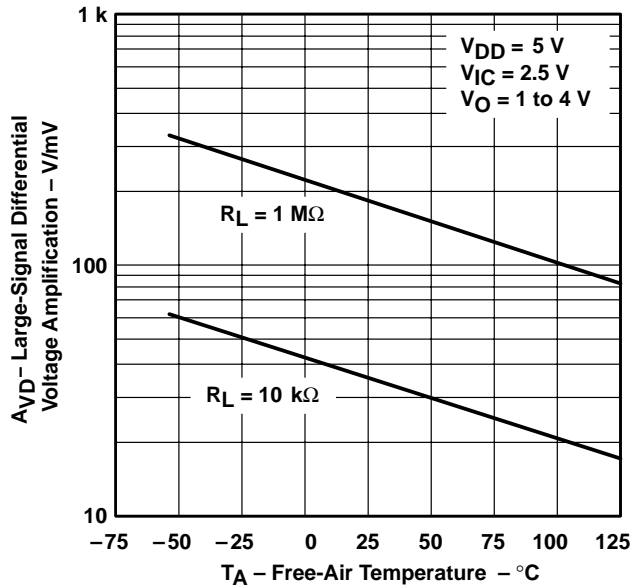


Figure 27

LARGE-SIGNAL DIFFERENTIAL
 VOLTAGE AMPLIFICATION†
 vs
 FREE-AIR TEMPERATURE

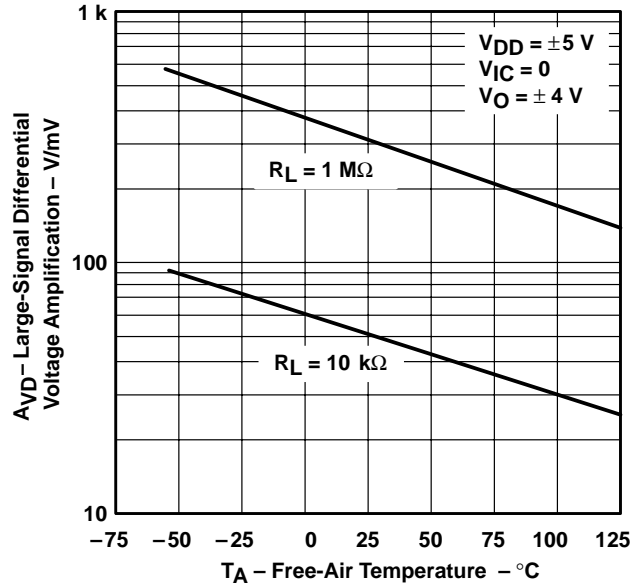


Figure 28

OUTPUT IMPEDANCE
 vs
 FREQUENCY

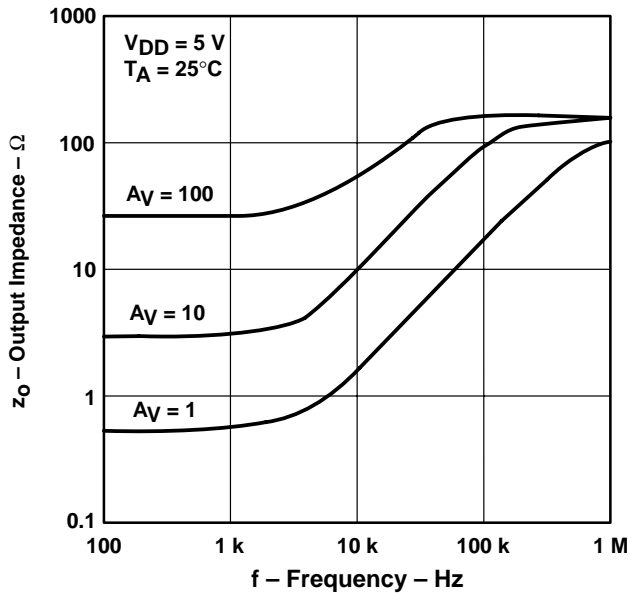


Figure 29

OUTPUT IMPEDANCE
 vs
 FREQUENCY

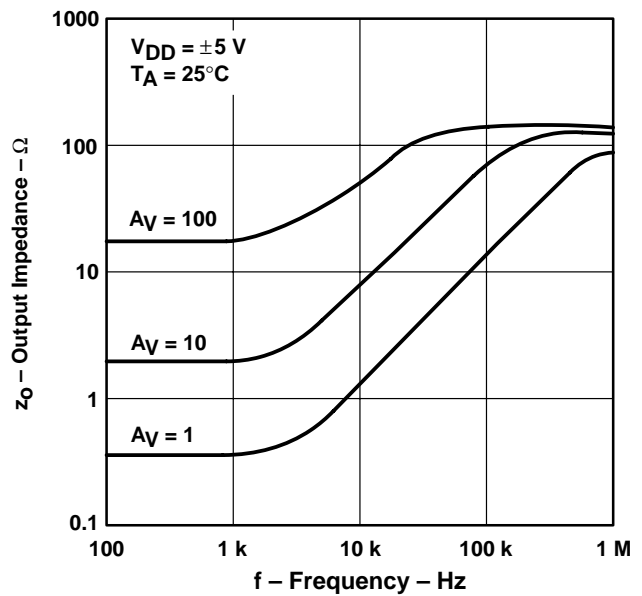


Figure 30

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

TYPICAL CHARACTERISTICS

COMMON-MODE REJECTION RATIO
 VS
 FREQUENCY

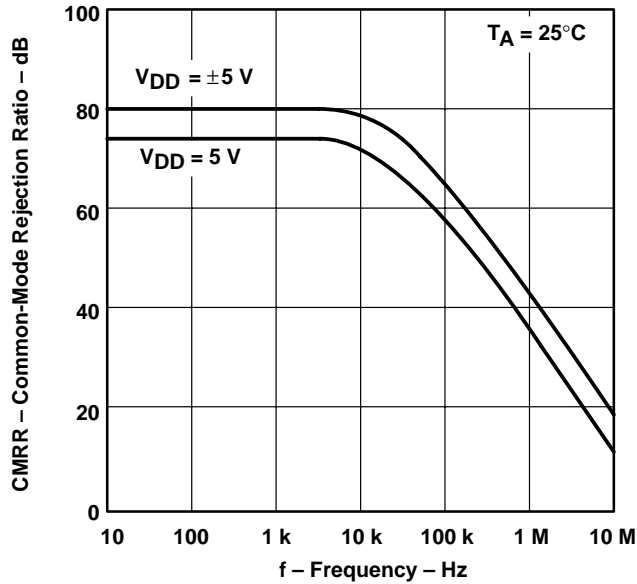


Figure 31

COMMON-MODE REJECTION RATIO
 VS
 FREE-AIR TEMPERATURE

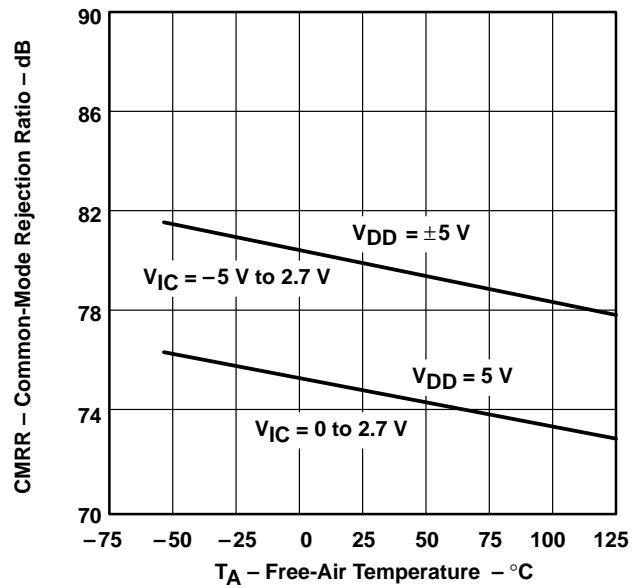


Figure 32

SUPPLY-VOLTAGE REJECTION RATIO
 VS
 FREQUENCY

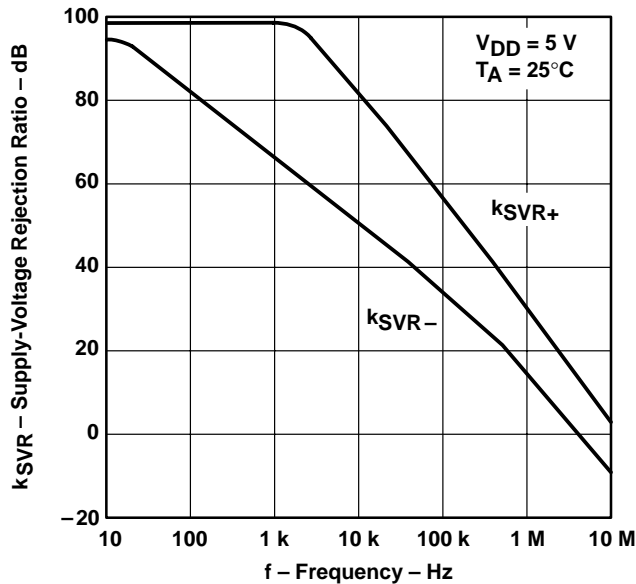


Figure 33

SUPPLY-VOLTAGE REJECTION RATIO
 VS
 FREQUENCY

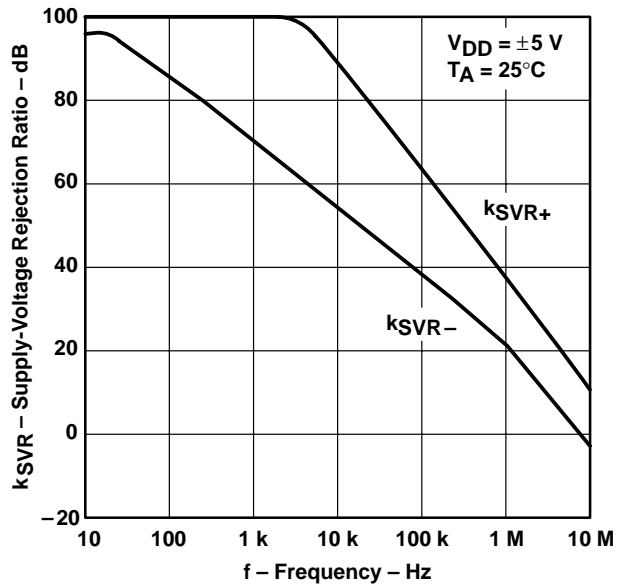
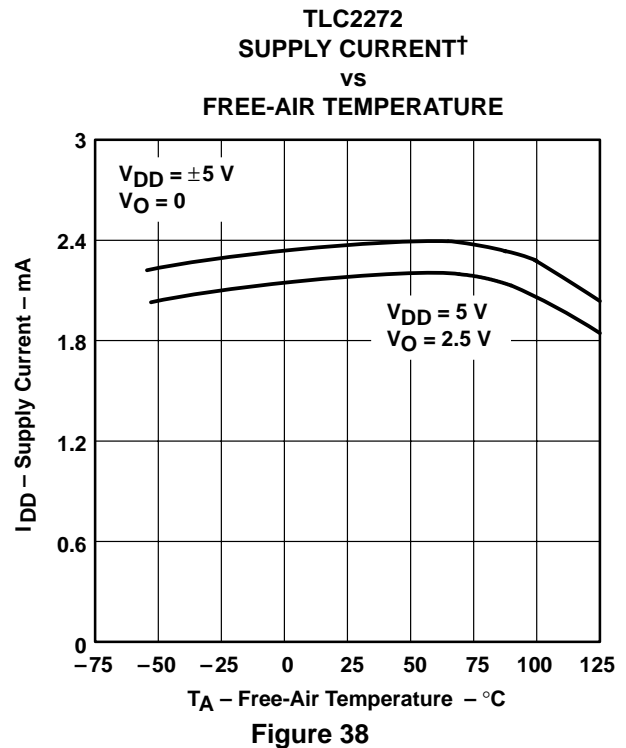
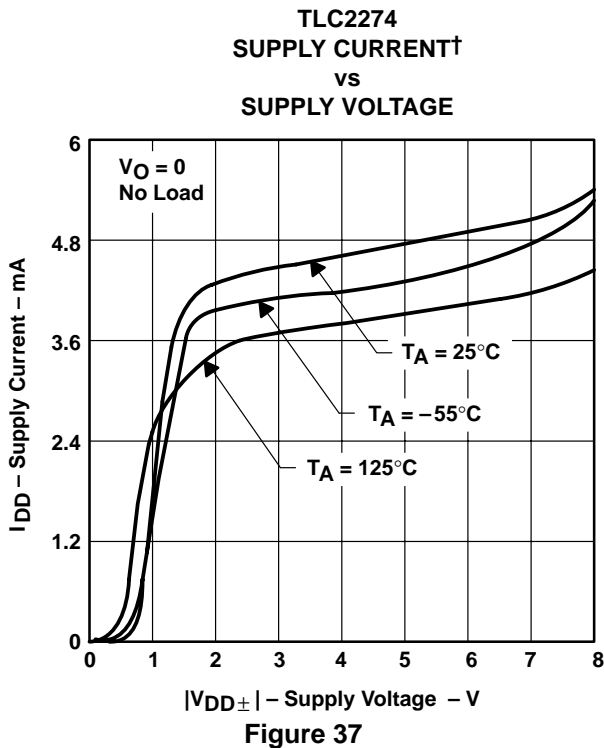
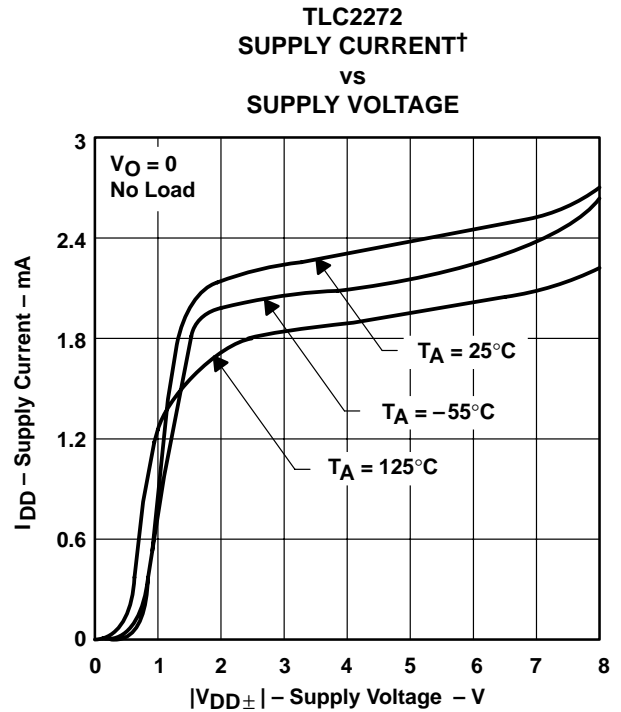
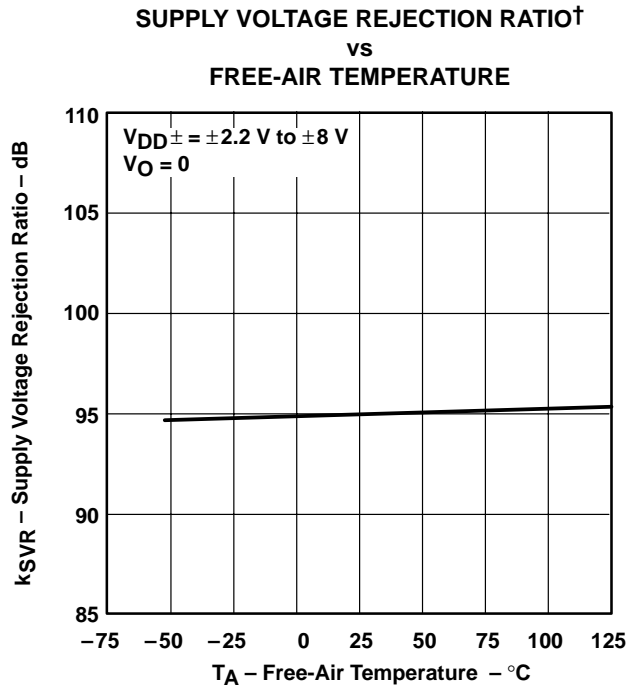


Figure 34

TYPICAL CHARACTERISTICS



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

TYPICAL CHARACTERISTICS

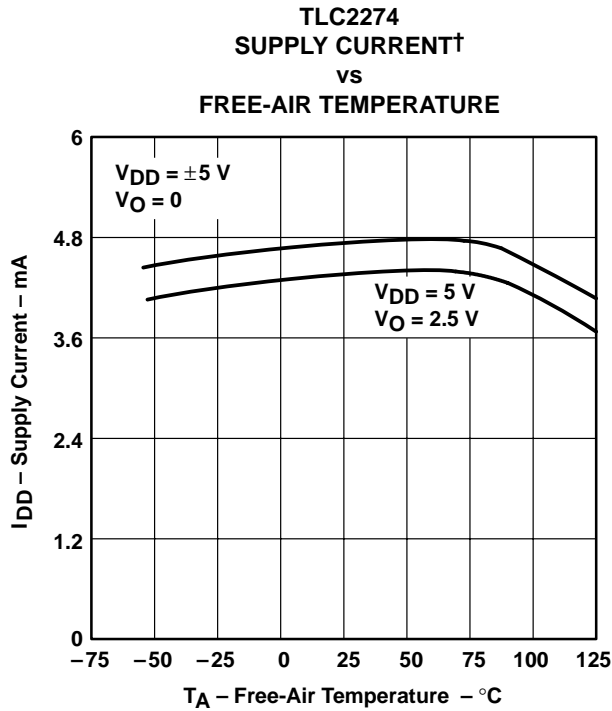


Figure 39

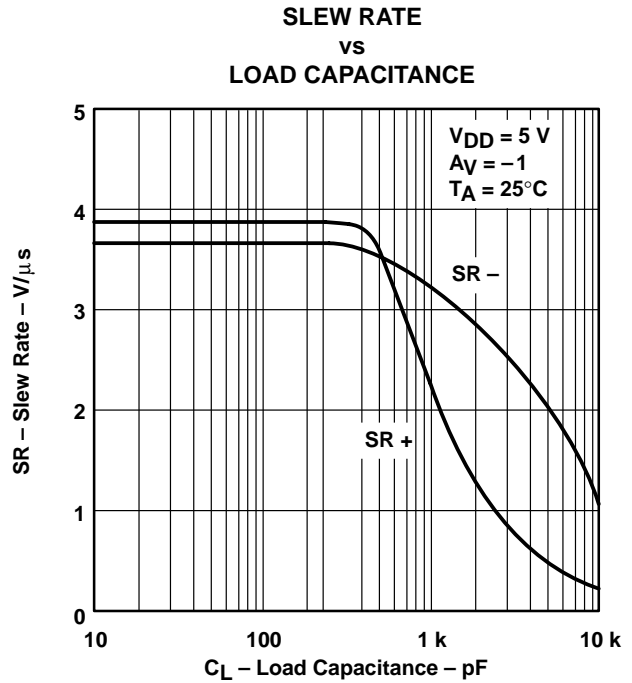


Figure 40

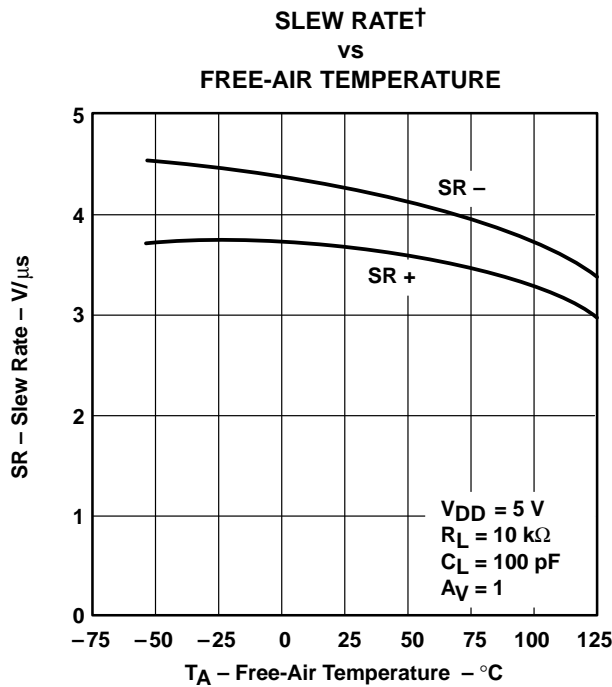


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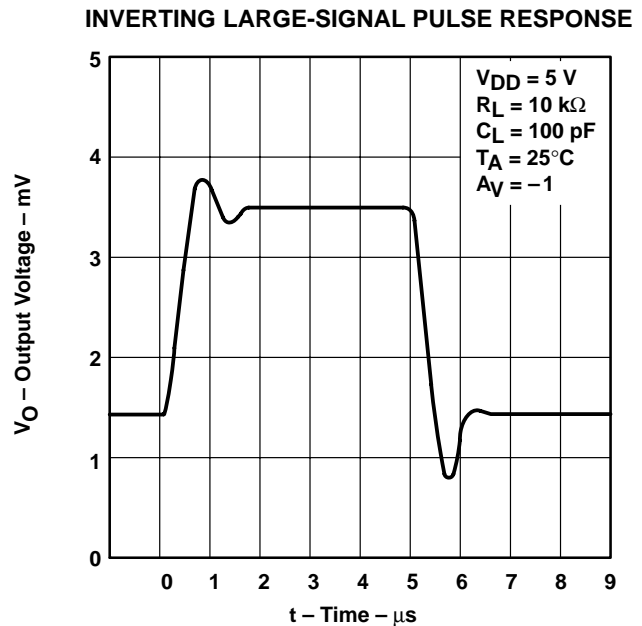


Figure 42

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

TYPICAL CHARACTERISTICS

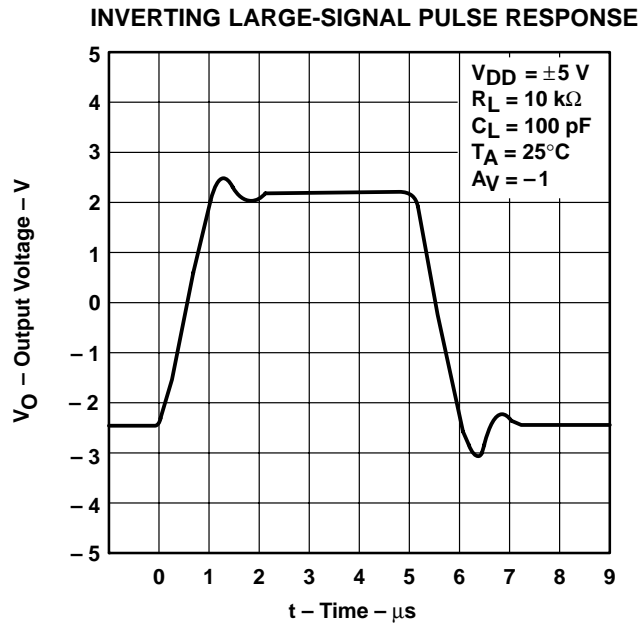


Figure 43

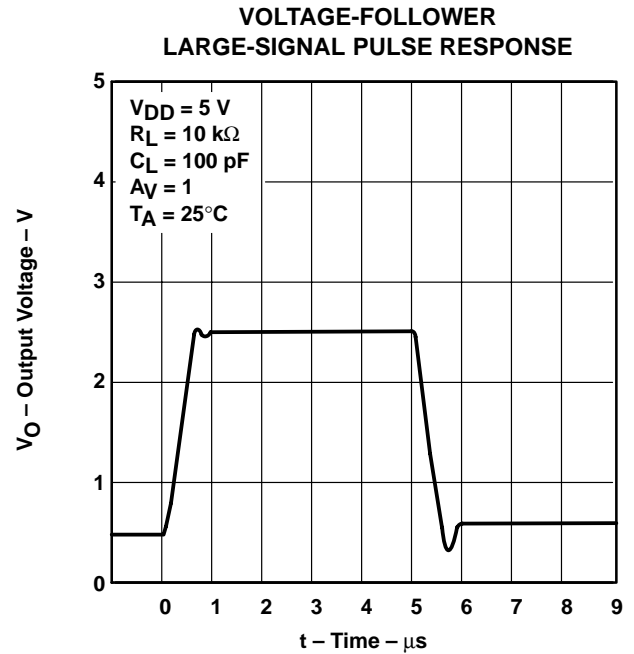


Figure 44

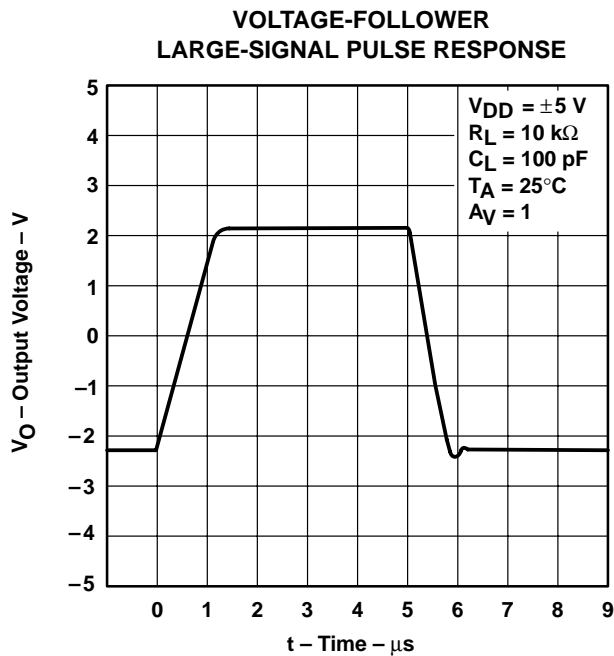


Figure 45

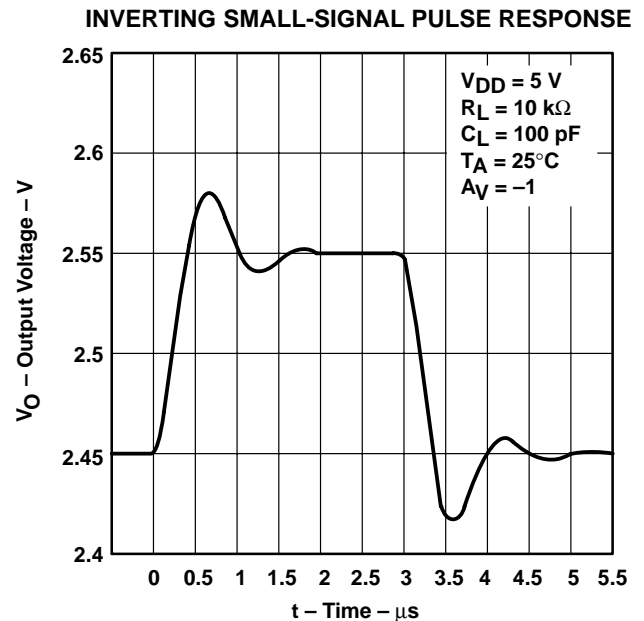


Figure 46

TYPICAL CHARACTERISTICS

INVERTING SMALL-SIGNAL PULSE RESPONSE

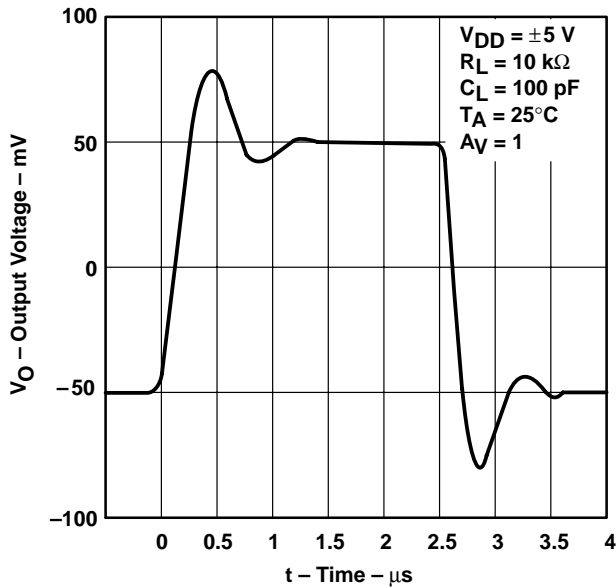


Figure 47

VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE

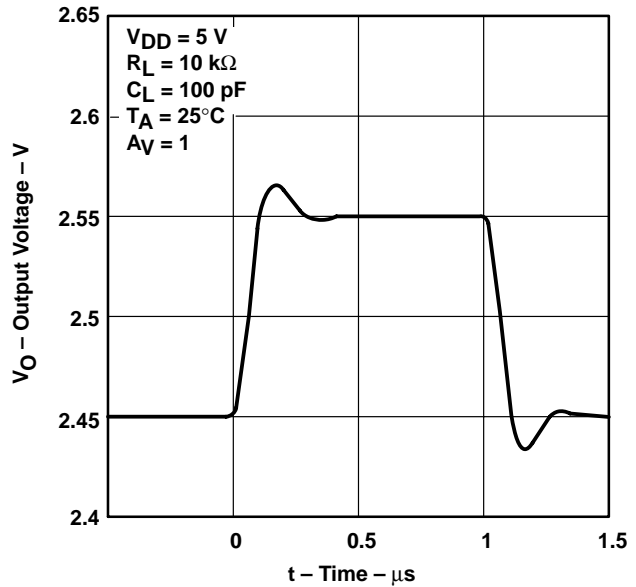


Figure 48

VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE

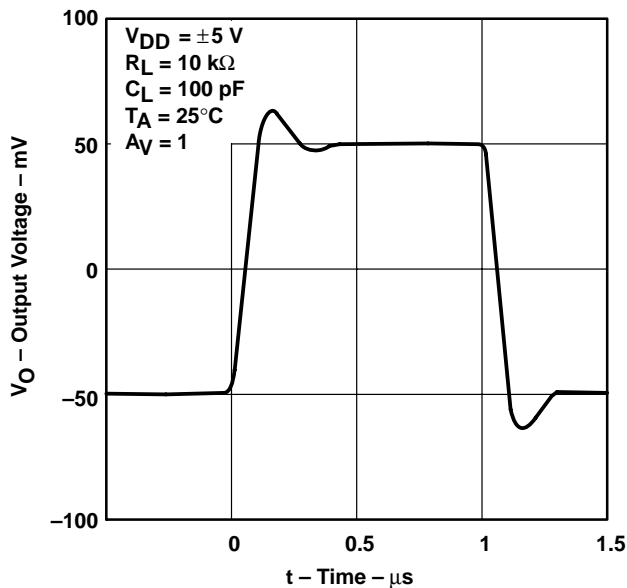


Figure 49

EQUIVALENT INPUT NOISE VOLTAGE VS FREQUENCY

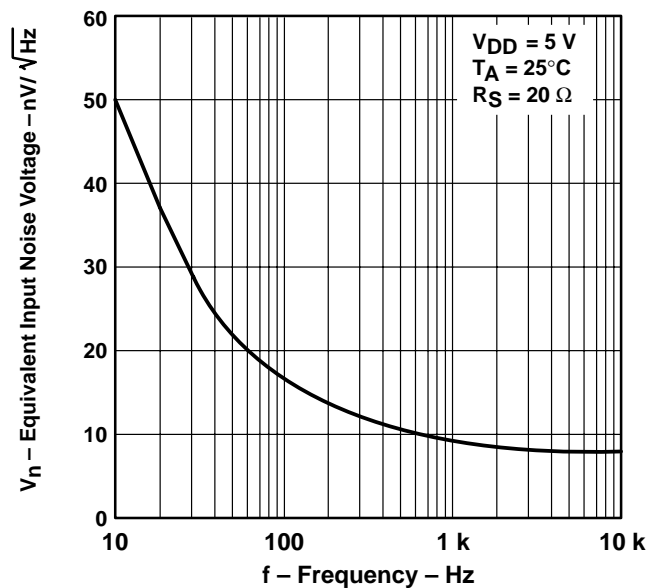
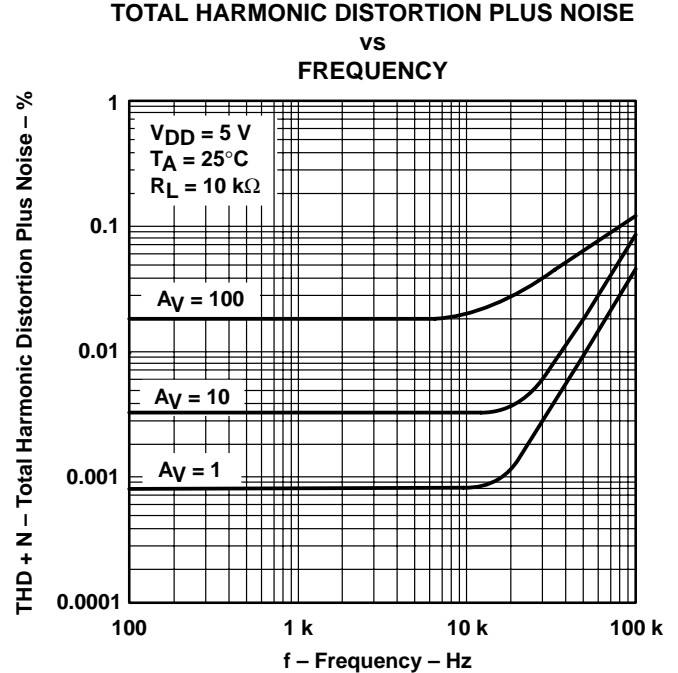
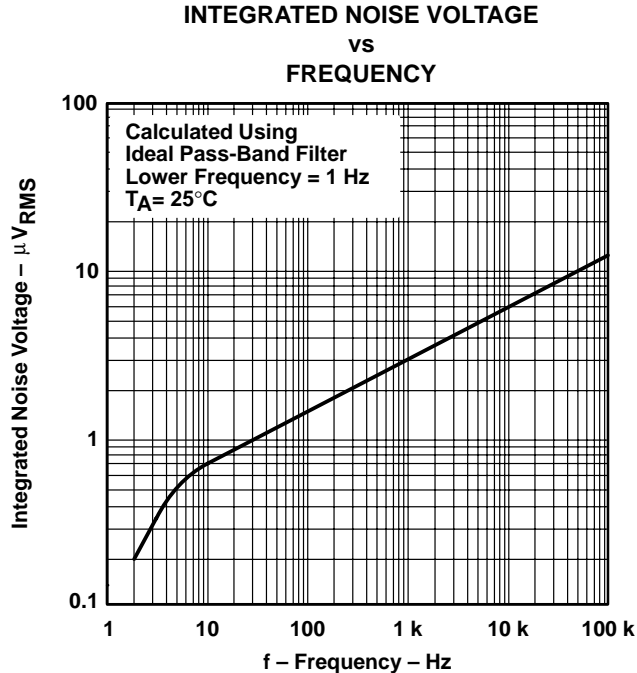
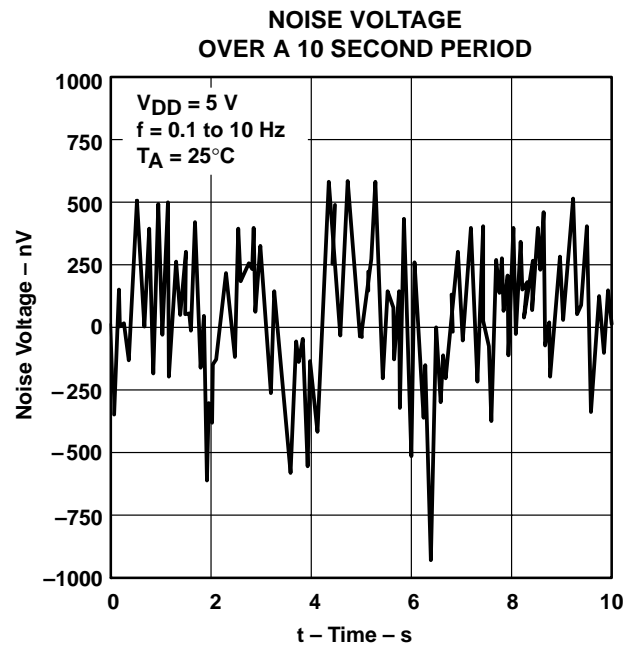
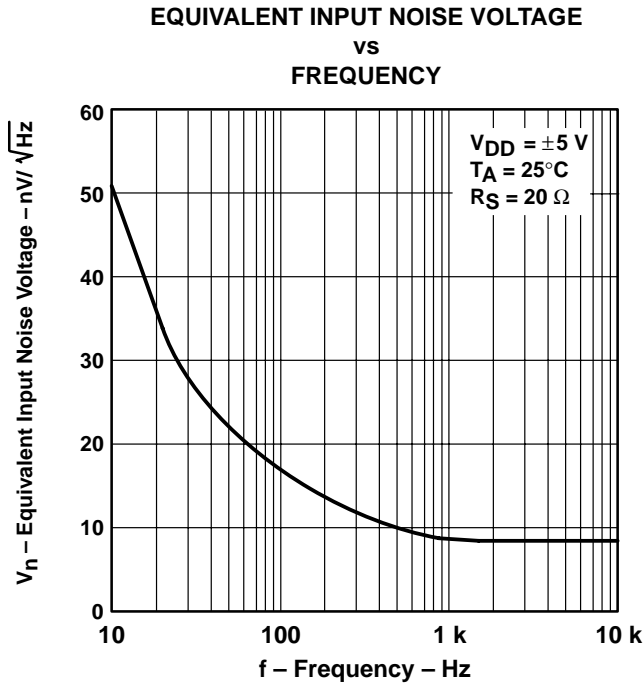


Figure 50

TYPICAL CHARACTERISTICS



TYPICAL CHARACTERISTICS

GAIN-BANDWIDTH PRODUCT
 vs
 SUPPLY VOLTAGE

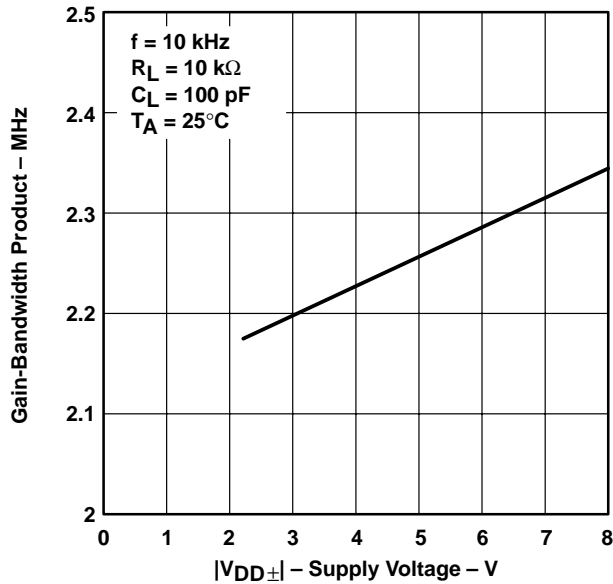


Figure 55

GAIN-BANDWIDTH PRODUCT†
 vs
 FREE-AIR TEMPERATURE

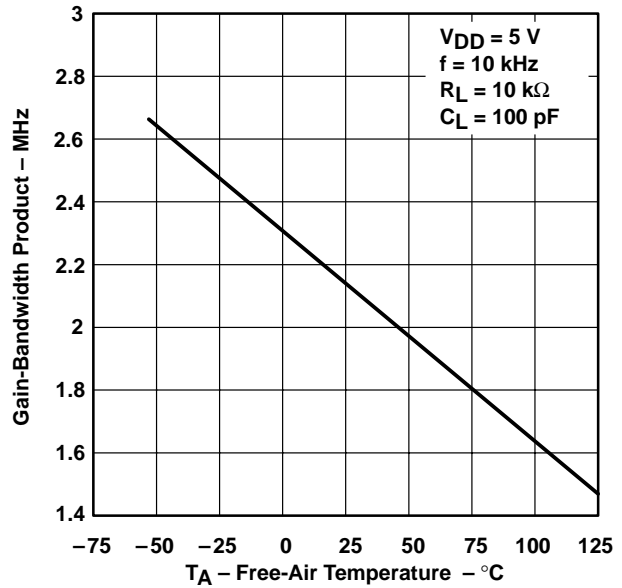


Figure 56

PHASE MARGIN
 vs
 LOAD CAPACITANCE

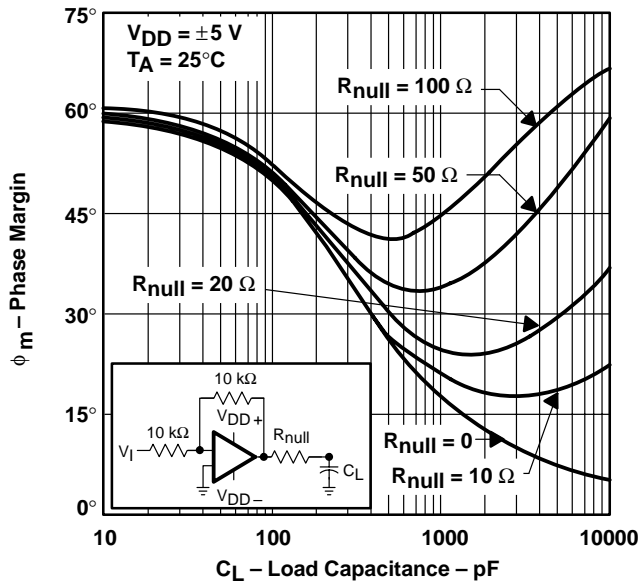


Figure 57

GAIN MARGIN
 vs
 LOAD CAPACITANCE

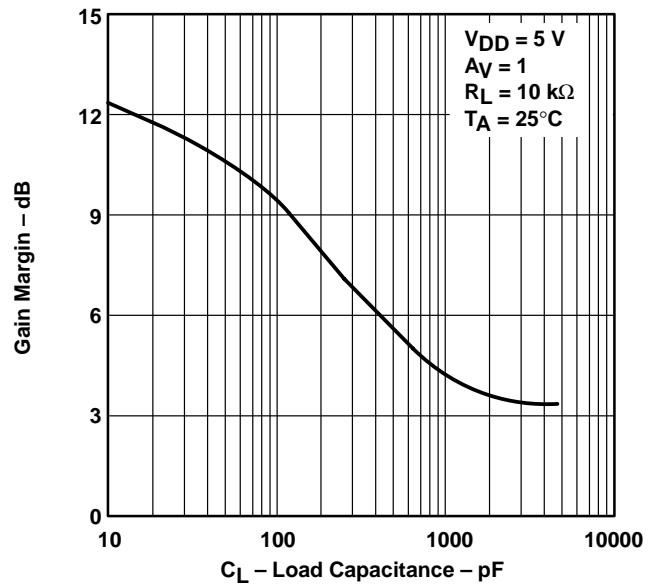


Figure 58

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

APPLICATION INFORMATION

macromodel information

Macromodel information provided was derived using Microsim *Parts*™, the model generation software used with Microsim *PSpice*™. The Boyle macromodel (see Note 5) and subcircuit in Figure 59 were generated using the TLC227x typical electrical and operating characteristics at $T_A = 25^\circ\text{C}$. Using this information, output simulations of the following key parameters can be generated to a tolerance of 20% (in most cases):

- Maximum positive output voltage swing
- Maximum negative output voltage swing
- Slew rate
- Quiescent power dissipation
- Input bias current
- Open-loop voltage amplification
- Unity gain frequency
- Common-mode rejection ratio
- Phase margin
- DC output resistance
- AC output resistance
- Short-circuit output current limit

NOTE 5: G. R. Boyle, B. M. Cohn, D. O. Pederson, and J. E. Solomon, "Macromodeling of Integrated Circuit Operational Amplifiers", *IEEE Journal of Solid-State Circuits*, SC-9, 353 (1974).

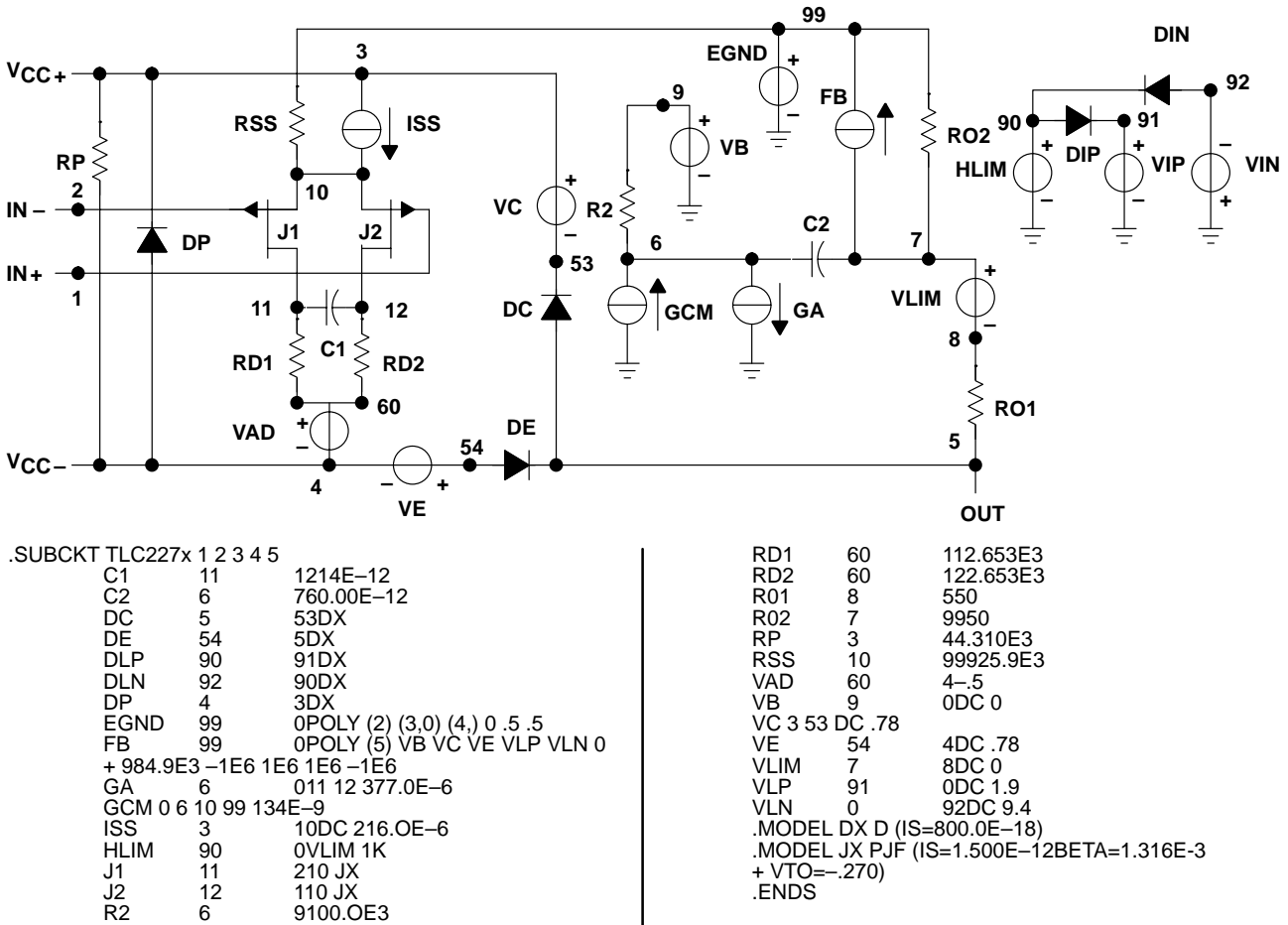


Figure 59. Boyle Macromodel and Subcircuit

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