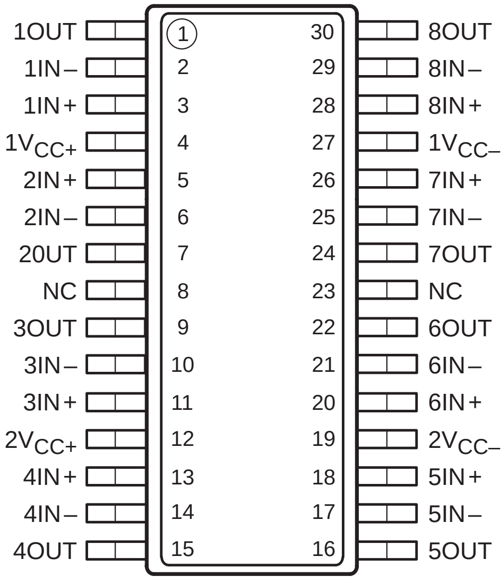
TLC274x2
LinCMOS™ PRECISION
OCTAL OPERATIONAL AMPLIFIER

SLOS137 – JULY 1994

- **Trimmed Offset Voltage**
  10 mV Max at T_A = 25°C, V_{DD} = 5 V
- **Input Offset Voltage Drift . . . Typically 0.1 µV/Month, Including the First 30 Days**
- **Wide Range of Supply Voltages**
  3 V to 16 V
- **Single-Supply Operation**
- **Common-Mode Input Voltage Range Extends Below the Negative Rail**
- **Low Noise . . . Typically 25 nV/$\sqrt{\text{Hz}}$ at f = 1 kHz**
- **Output Voltage Range Includes Negative Rail**
- **ESD-Protection Circuitry**
- **Small-Outline Package Option Also Available in Tape and Reel**
- **Designed-In Latch-Up Immunity**

DB PACKAGE
(TOP VIEW)

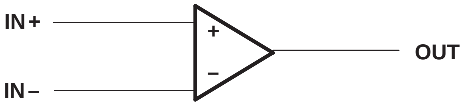


NC – No internal connection

description

The TLC274x2 octal operational amplifier incorporates low offset-voltage drift, high input impedance, low noise, and speeds approaching that of general-purpose BiFET devices into a single package. This device uses Texas Instruments silicon-gate LinCMOS™ technology, which provides offset voltage stability far exceeding the stability available with conventional metal-gate processes.

symbol (each amplifier)



The extremely high input impedance, low bias currents, and high slew rates make this a cost-effective device ideal for applications that have previously been reserved for BiFET and NFET products. These advantages, in combination with good common-mode rejection and supply-voltage rejection, make this device a good choice for new state-of-the-art designs as well as for upgrading existing designs.

In general, many features associated with bipolar technology are available on LinCMOS™ operational amplifiers without the power penalties of bipolar technology. General applications such as transducer interfacing, analog calculations, amplifier blocks, active filters, and signal buffering are easily designed with the TLC274x2. The device also exhibits low-voltage single-supply operation, making them ideally suited for remote and inaccessible battery-powered applications. The common-mode input voltage range includes the negative rail. The device inputs and outputs are designed to withstand –100-mA surge currents without sustaining latch-up.

AVAILABLE OPTION

T_A	V_{IO}max AT 25°C	PACKAGE
		SMALL OUTLINE (DB)[†]
0°C to 70°C	10 mV	TLC274x2DBLE

[†] The DB package is only available left-end taped and reeled.

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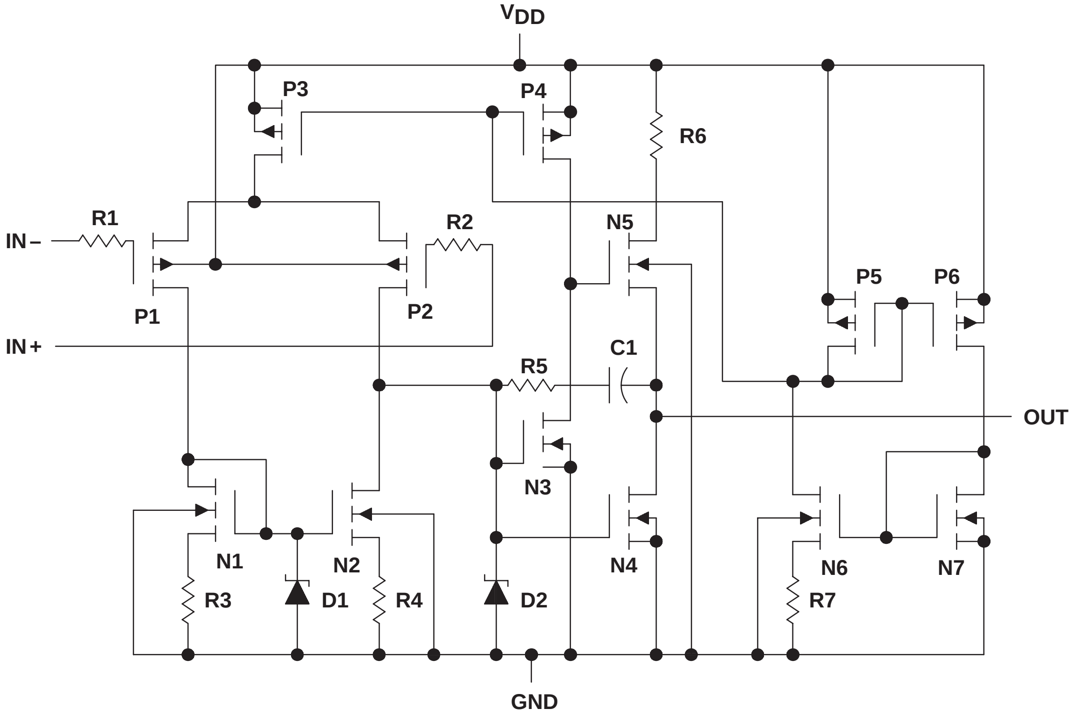
description (continued)

The TLC274x2 incorporates internal ESD-protection circuits that prevent functional failures at voltages up to 2000 V as tested under MIL-STD-883C, Method 3015.2; however, exercise care in handling this device as exposure to ESD can result in the degradation of the device parametric performance.

The TLC274x2 is characterized for operation from 0°C to 70°C.

equivalent schematic (each amplifier)



COMPONENT COUNT	
Resistors	56
Transistors	80
Diodes	16
Capacitors	8

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

Supply voltage, V_{DD} (see Note 1)	18 V
Differential input voltage, V_{ID} (see Note 2)	$V_{DD}\pm$
Input voltage range, V_I (any input)	–0.3 V to V_{DD}
Input current, I_I	±5 mA
Output current, I_O (each output)	±30 mA
Total current into V_{DD}	45 mA
Total current out of GND	45 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, T_A	0°C to 70°C
Storage temperature range	–65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°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 network ground.
2. Differential voltages are at IN+ with respect to IN–.
3. The output can be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded (see application section).

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING
DB	1024 mW	8.2 mW/°C	655 mW

recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, V_{DD}		3	16	V
Common-mode input voltage, V_{IC}	V_{DD} = 5 V	–0.2	3.5	V
	V_{DD} = 10 V	–0.2	8.5	
Operating free-air temperature, T_A		0	70	°C

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

PARAMETER		TEST CONDITIONS		T_A†	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 10 kΩ	25°C		1.1	10	mV
				Full range			12	
α_{VIO}	Average temperature coefficient of input offset voltage			25°C to 70°C		1.8		µV/°C
I_{IO}	Input offset current (see Note 4)	V_O = 2.5 V,	V_{IC} = 2.5 V	25°C		0.1		pA
				70°C		7	300	
I_{IB}	Input bias current (see Note 4)	V_O = 2.5 V,	V_{IC} = 2.5 V	25°C		0.6		pA
				70°C		40	600	
V_{ICR}	Common-mode input voltage range (see Note 5)			25°C	–0.2 to 4	–0.3 to 4.2		V
				Full range	–0.2 to 3.5			V
V_{OH}	High-level output voltage	V_{ID} = 100 mV,	R_L = 10 kΩ	25°C	3.2	3.8		V
				0°C	3	3.8		
				70°C	3	3.8		
V_{OL}	Low-level output voltage	V_{ID} = –100 mV,	I_{OL} = 0	25°C		0	50	mV
				0°C		0	50	
				70°C		0	50	
A_{VD}	Large-signal differential voltage amplification	V_O = 0.25 V to 2 V,	R_L = 10 kΩ	25°C	5	23		V/mV
				0°C	4	27		
				70°C	4	20		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}\text{min}$		25°C	65	80		dB
				0°C	60	84		
				70°C	60	85		
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{DD} = 5 V to 10 V,	V_O = 1.4 V	25°C	65	95		dB
				0°C	60	94		
				70°C	60	96		
I_{DD}	Supply current (four amplifiers)	V_O = 2.5 V, No load	V_{IC} = 2.5 V,	25°C		2.7	6.4	mA
				0°C		3.1	7.2	
				70°C		2.3	5.2	

† Full range is 0°C to 70°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.
5. This range also applies to each input individually.

electrical characteristics at specified free-air temperature, V_{DD} = 10 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 10 kΩ	25°C		1.1	10	mV
				Full range			12	
α_{VIO}	Average temperature coefficient of input offset voltage			25°C to 70°C		2		µV/°C
I_{IO}	Input offset current (see Note 4)	V_O = 0.5 V,	V_{IC} = 5 V	25°C		0.1		pA
				70°C		7	300	
I_{IB}	Input bias current (see Note 4)	V_O = 5 V,	V_{IC} = 5 V	25°C		0.7		pA
				70°C		50	600	
V_{ICR}	Common-mode input voltage range (see Note 5)			25°C	–0.2 to 9	–0.3 to 9.2		V
				Full range	–0.2 to 8.5			V
V_{OH}	High-level output voltage	V_{ID} = 100 mV,	R_L = 10 kΩ	25°C	8	8.5		V
				0°C	7.8	8.5		
				70°C	7.8	8.4		
V_{OL}	Low-level output voltage	V_{ID} = –100 mV,	I_{OL} = 0	25°C		0	50	mV
				0°C		0	50	
				70°C		0	50	
A_{VD}	Large-signal differential voltage amplification	V_O = 1 V to 6 V,	R_L = 10 kΩ	25°C	10	36		V/mV
				0°C	7.5	42		
				70°C	7.5	32		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}\text{min}$		25°C	65	85		dB
				0°C	60	88		
				70°C	60	88		
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{DD} = 5 V to 10 V,	V_O = 1.4 V	25°C	65	95		dB
				0°C	60	94		
				70°C	60	96		
I_{DD}	Supply current (four amplifiers)	V_O = 5 V, No load	V_{IC} = 5 V,	25°C		3.8	8	mA
				0°C		4.5	8.8	
				70°C		3.2	6.8	

† Full range is 0°C to 70°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.
5. This range also applies to each input individually.

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

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	R_L = 10 Ω, C_L = 20 pF, See Figure 1	$V_{I(PP)}$ = 1 V	25°C		3.6		V/μs
				0°C		4		
				70°C		3		
			$V_{I(PP)}$ = 2.5 V	25°C		2.9		
				0°C		3.1		
				70°C		2.5		
V_n	Equivalent input noise voltage	f = 1 kHz, See Figure 2	R_S = 20 Ω,	25°C		25		$\mathrm{nV}/\sqrt{\mathrm{Hz}}$
B_{OM}	Maximum output-swing bandwidth	V_O = V_{OH}, R_L = 10 kΩ,	C_L = 20 pF, See Figure 1	25°C		320		kHz
				0°C		340		
				70°C		260		
B_1	Unity-gain bandwidth	V_I = 10 mV, See Figure 3	C_L = 20 pF,	25°C		1.7		MHz
				0°C		2		
				70°C		1.3		
ϕ_m	Phase margin	V_I = 10 mV, C_L = 20 pF,	f = B_1,	25°C		46°		
				0°C		47°		
				70°C		44°		

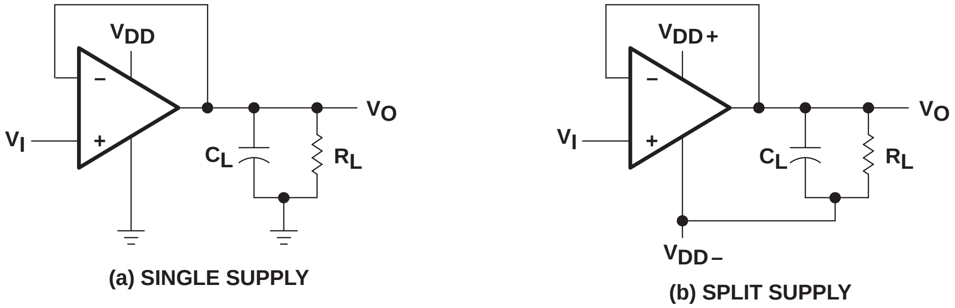
operating characteristics at specified free-air temperature, V_{DD} = 10 V

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	R_L = 10 Ω, C_L = 20 pF, See Figure 1	$V_{I(PP)}$ = 1 V	25°C		5.3		V/μs
				0°C		5.9		
				70°C		4.3		
			$V_{I(PP)}$ = 5.5 V	25°C		4.6		
				0°C		5.1		
				70°C		3.8		
V_n	Equivalent input noise voltage	f = 1 kHz, See Figure 2	R_S = 20 Ω,	25°C		25		$\mathrm{nV}/\sqrt{\mathrm{Hz}}$
B_{OM}	Maximum output-swing bandwidth	V_O = V_{OH}, R_L = 10 kΩ,	C_L = 20 pF, See Figure 1	25°C		200		kHz
				0°C		220		
				70°C		140		
B_1	Unity-gain bandwidth	V_I = 10 mV, See Figure 3	C_L = 20 pF,	25°C		2.2		MHz
				0°C		2.5		
				70°C		1.8		
ϕ_m	Phase margin	V_I = 10 mV, C_L = 20 pF,	f = B_1, See Figure 3	25°C		49°		
				0°C		50°		
				70°C		46°		

PARAMETER MEASUREMENT INFORMATION

single-supply versus split-supply test circuits

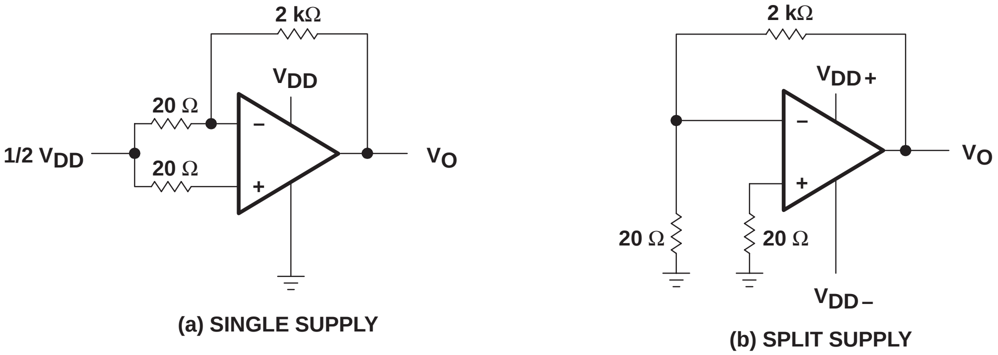
Because the TLC274x2 is optimized for single-supply operation, circuit configurations used for the various tests often present some inconvenience since the input signal, in many cases, must be offset from ground. This inconvenience can be avoided by testing the device with split supplies and the output load tied to the negative rail. A comparison of single-supply versus split-supply test circuits is shown below. The use of either circuit gives the same result.



(a) SINGLE SUPPLY

(b) SPLIT SUPPLY

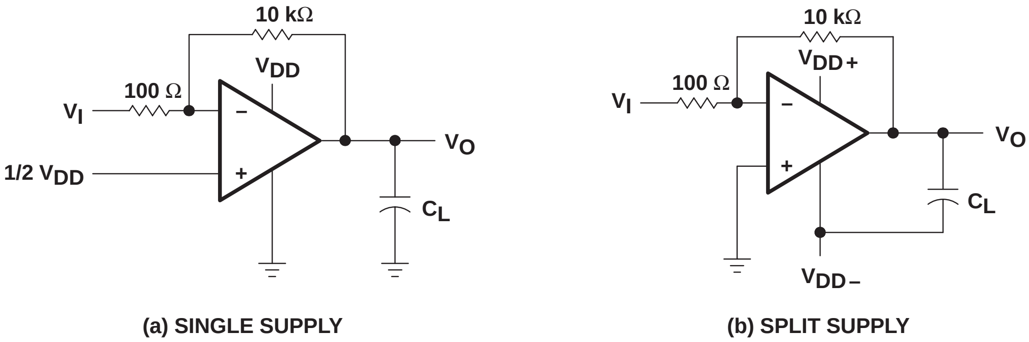
Figure 1. Unity-Gain Amplifier



(a) SINGLE SUPPLY

(b) SPLIT SUPPLY

Figure 2. Noise-Test Circuit



(a) SINGLE SUPPLY

(b) SPLIT SUPPLY

Figure 3. Gain-of-100 Inverting Amplifier

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
V_{OH}	High-level output voltage	vs High-level output current vs Supply voltage vs Free-air temperature	4, 5 6 7
V_{OL}	Low-level output voltage	vs Common-mode input voltage vs Differential input voltage vs Free-air temperature vs Low-level output current	8, 9 10 11 12, 13
A_{VD}	Large-signal differential voltage amplification	vs Supply voltage vs Free-air temperature vs Frequency	14 15 26, 27
I_{IB}	Input bias current	vs Free-air temperature	16
I_{IO}	Input offset current	vs Free-air temperature	16
V_{IC}	Common-mode input voltage	vs Supply voltage	17
I_{DD}	Supply current	vs Supply voltage vs Free-air temperature	18 19
SR	Slew rate	vs Supply voltage vs Free-air temperature	20 21
	Normalized slew rate	vs Free-air temperature	22
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency	23
B_1	Unity-gain bandwidth	vs Free-air temperature vs Supply voltage	24 25
ϕ_m	Phase margin	vs Supply voltage vs Free-air temperature vs Load capacitance	28 29 30
V_n	Equivalent input noise voltage	vs Frequency	31
	Phase shift	vs Frequency	26, 27

TYPICAL CHARACTERISTICS

HIGH-LEVEL OUTPUT VOLTAGE vs HIGH-LEVEL OUTPUT CURRENT

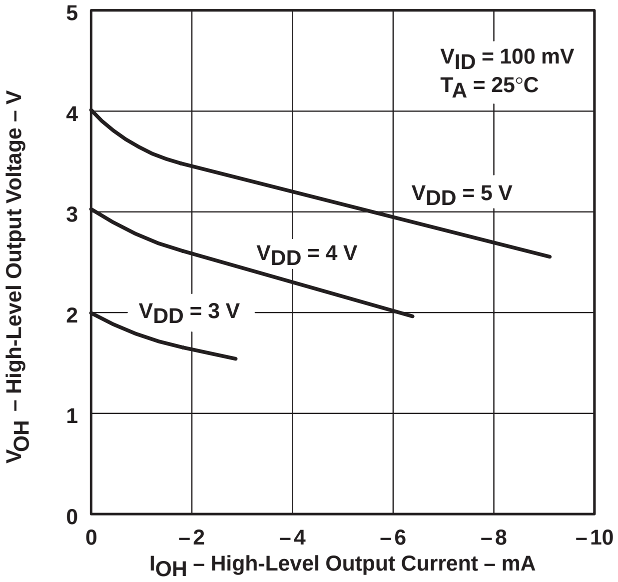


Figure 4

HIGH-LEVEL OUTPUT VOLTAGE vs HIGH-LEVEL OUTPUT CURRENT

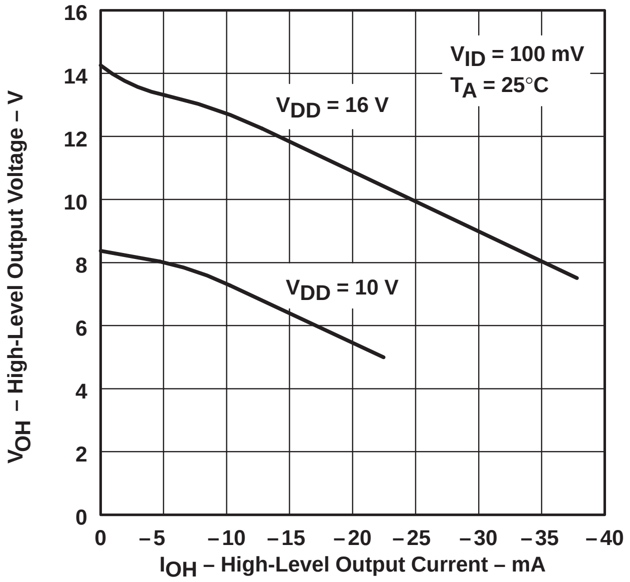


Figure 5

HIGH-LEVEL OUTPUT VOLTAGE vs SUPPLY VOLTAGE

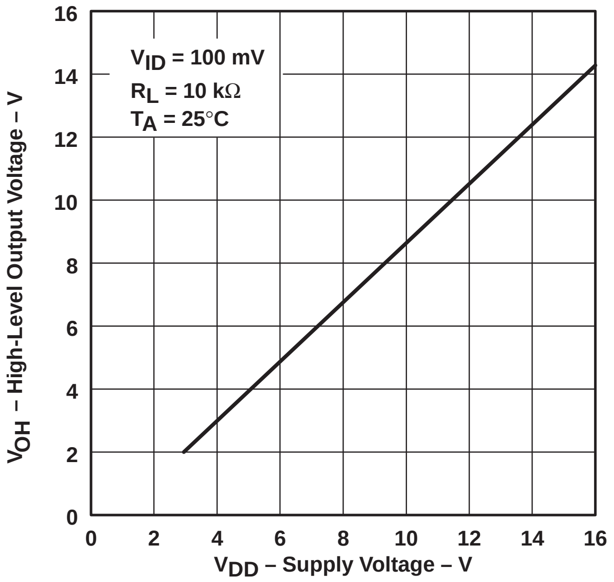


Figure 6

HIGH-LEVEL OUTPUT VOLTAGE vs FREE-AIR TEMPERATURE

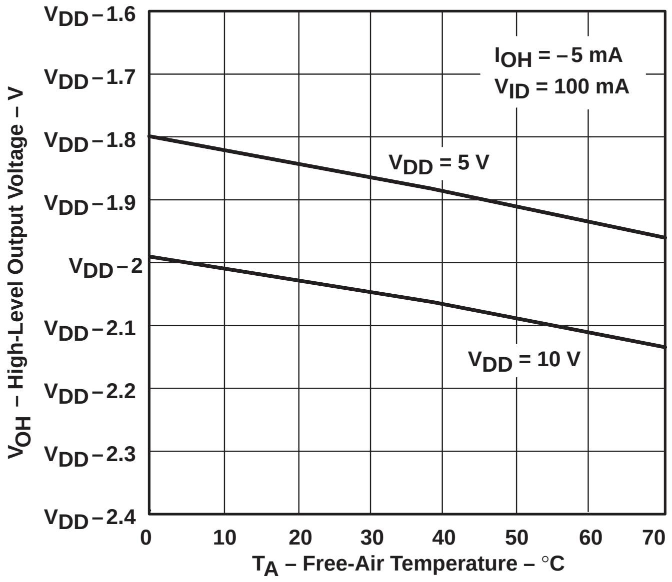


Figure 7

TYPICAL CHARACTERISTICS

LOW-LEVEL OUTPUT VOLTAGE vs COMMON-MODE INPUT VOLTAGE

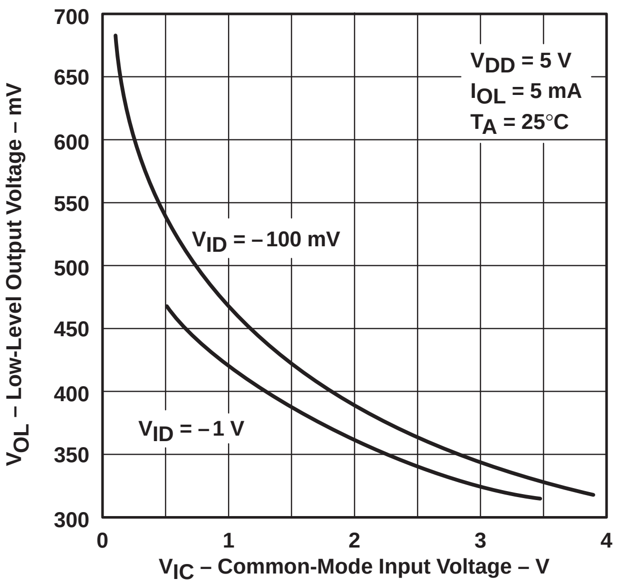


Figure 8

LOW-LEVEL OUTPUT VOLTAGE vs COMMON-MODE INPUT VOLTAGE

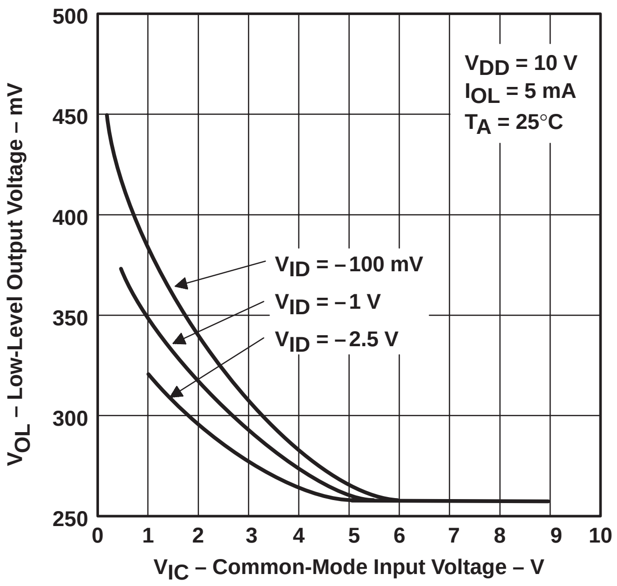


Figure 9

LOW-LEVEL OUTPUT VOLTAGE vs DIFFERENTIAL INPUT VOLTAGE

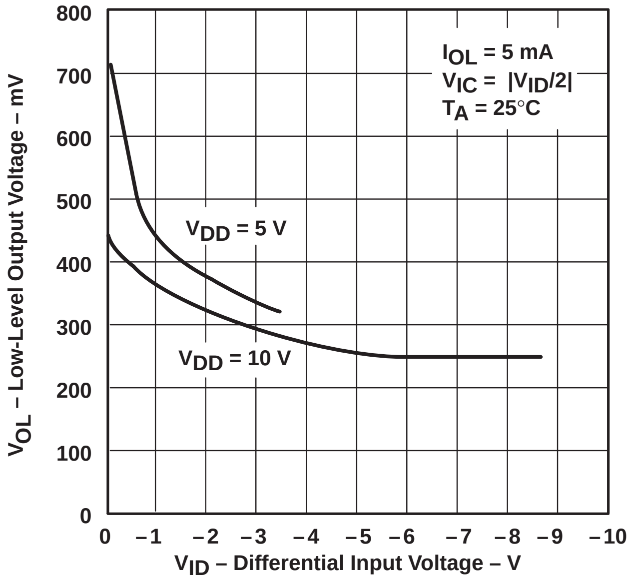


Figure 10

LOW-LEVEL OUTPUT VOLTAGE vs FREE-AIR TEMPERATURE

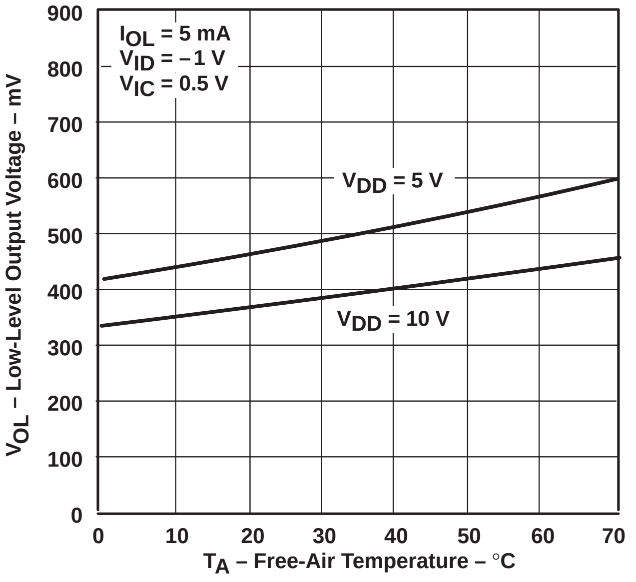


Figure 11

TYPICAL CHARACTERISTICS

LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT

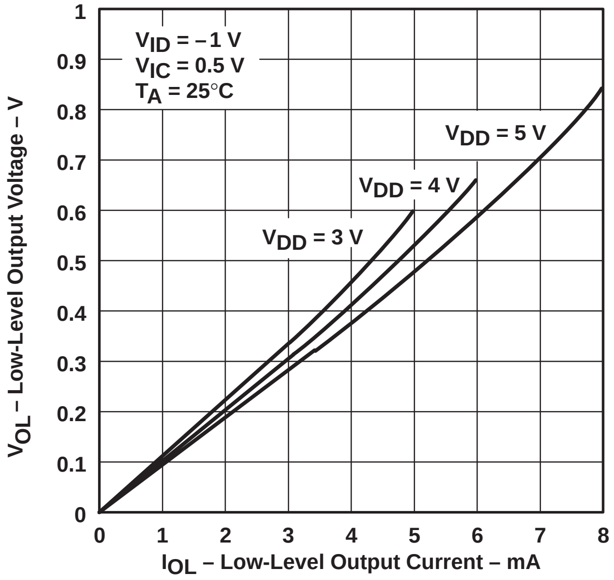


Figure 12

LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT

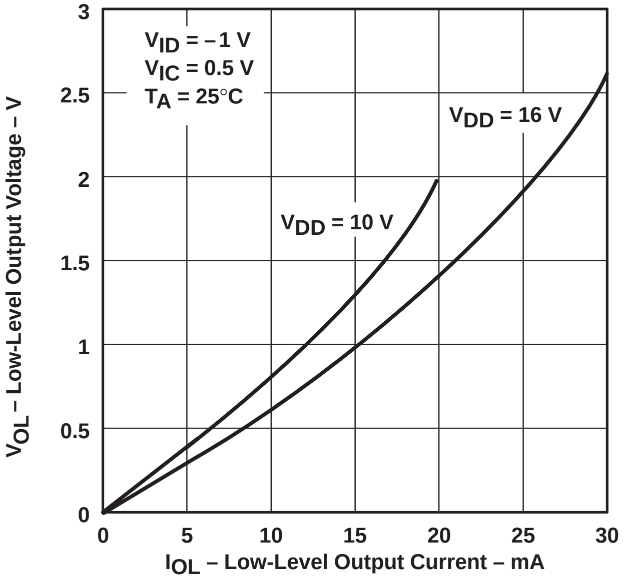


Figure 13

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs SUPPLY VOLTAGE

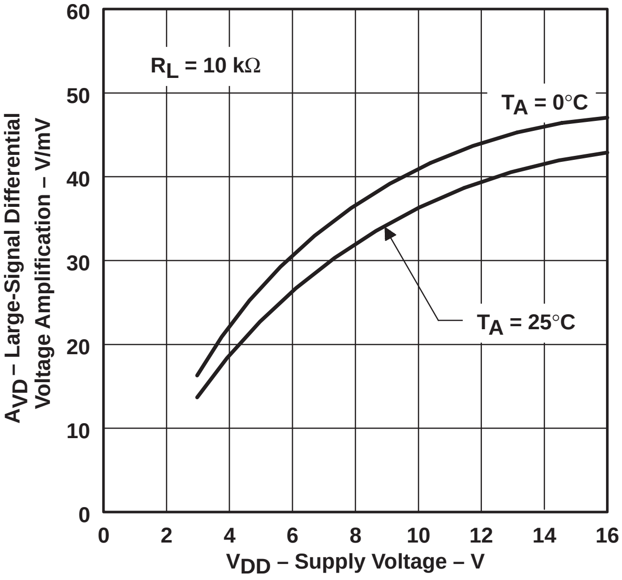


Figure 14

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

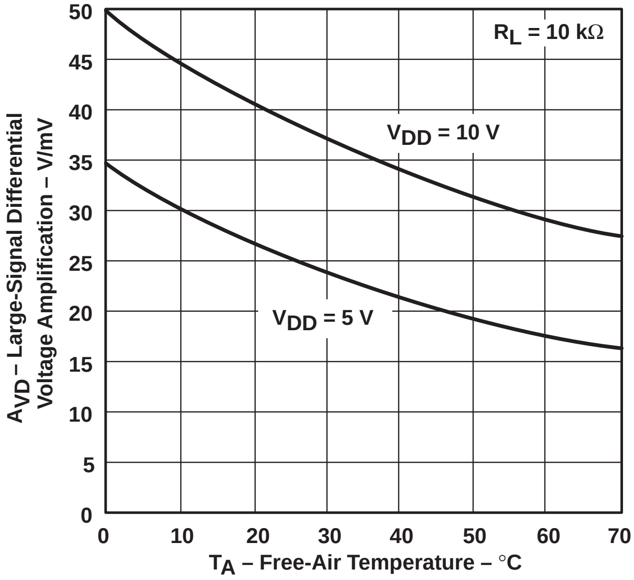
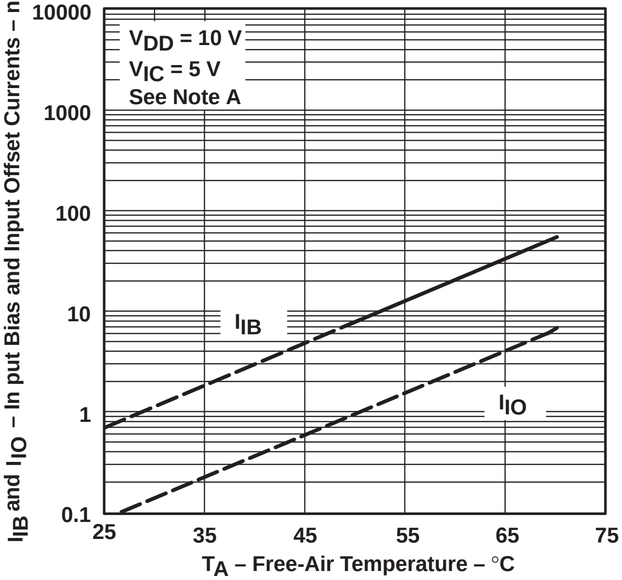


Figure 15

TYPICAL CHARACTERISTICS

INPUT BIAS CURRENT AND
INPUT OFFSET CURRENT
vs
FREE-AIR TEMPERATURE



NOTE A: The typical values of input bias current and input offset current below 5 pA were determined mathematically.

Figure 16

COMMON-MODE INPUT VOLTAGE
vs
SUPPLY VOLTAGE

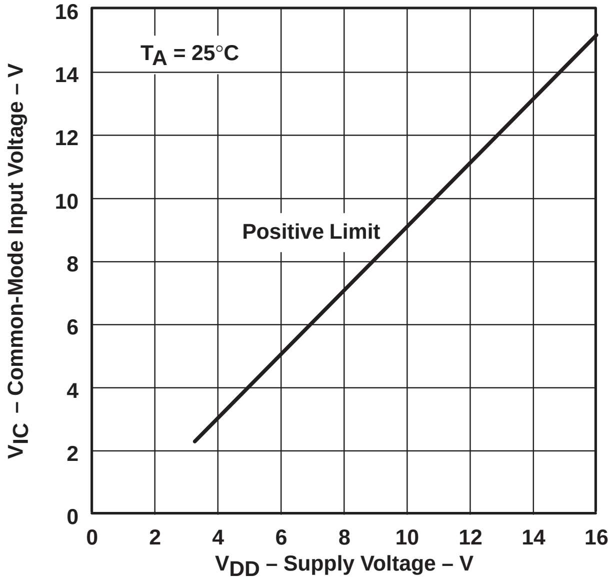


Figure 17

SUPPLY CURRENT
vs
SUPPLY VOLTAGE

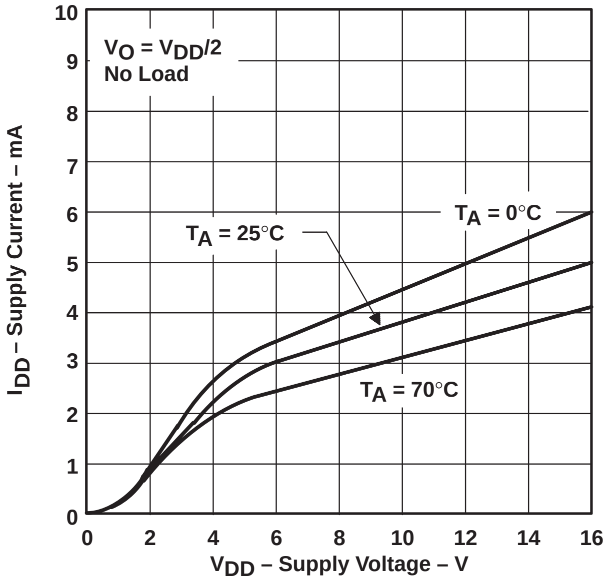


Figure 18

SUPPLY CURRENT
vs
FREE-AIR TEMPERATURE

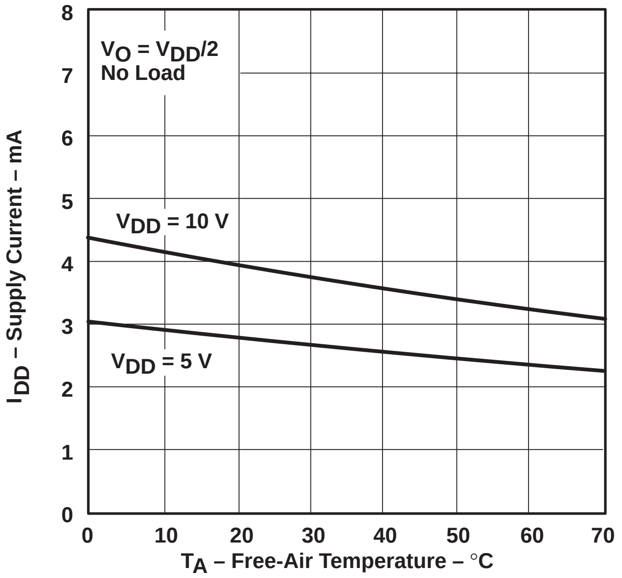


Figure 19

TYPICAL CHARACTERISTICS

SLEW RATE vs SUPPLY VOLTAGE

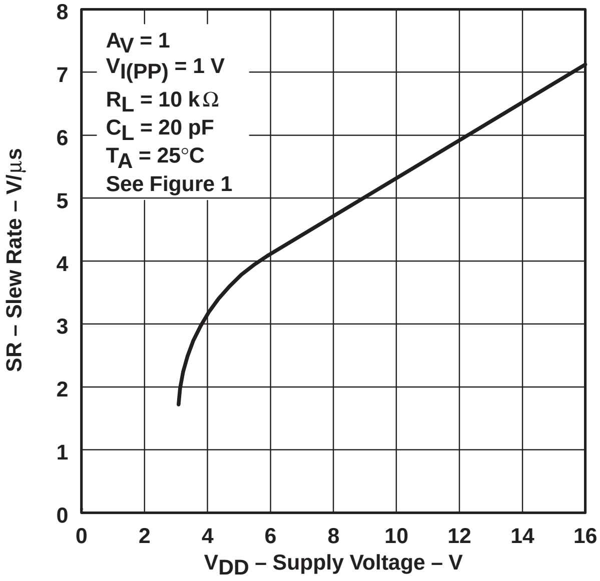


Figure 20

SLEW RATE vs FREE-AIR TEMPERATURE

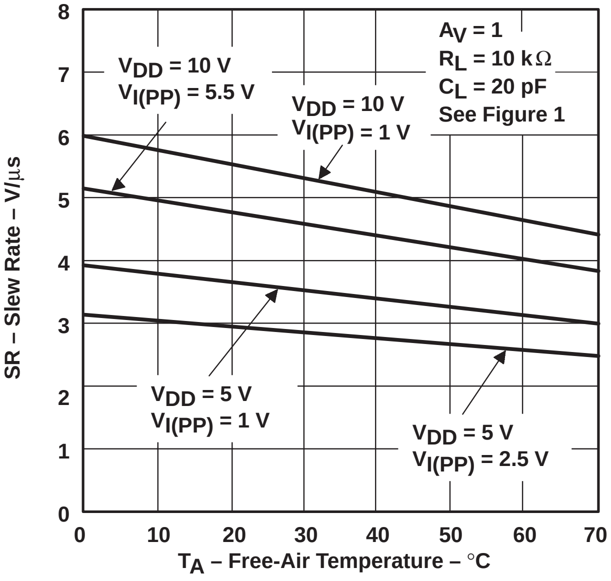


Figure 21

NORMALIZED SLEW RATE vs FREE-AIR TEMPERATURE

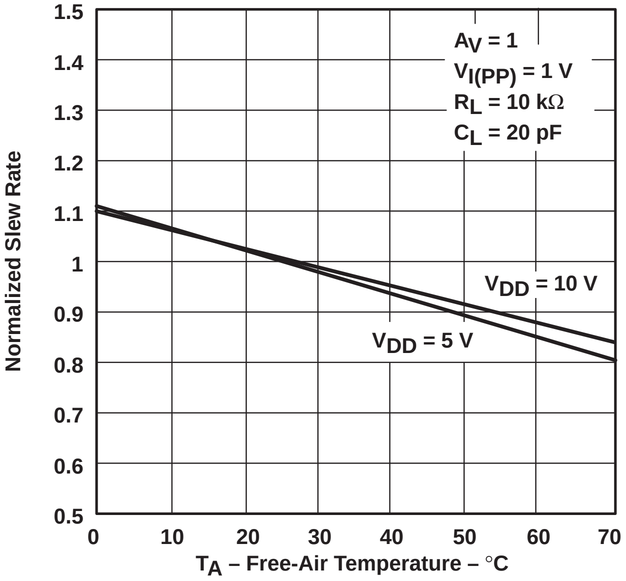


Figure 22

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE vs FREQUENCY

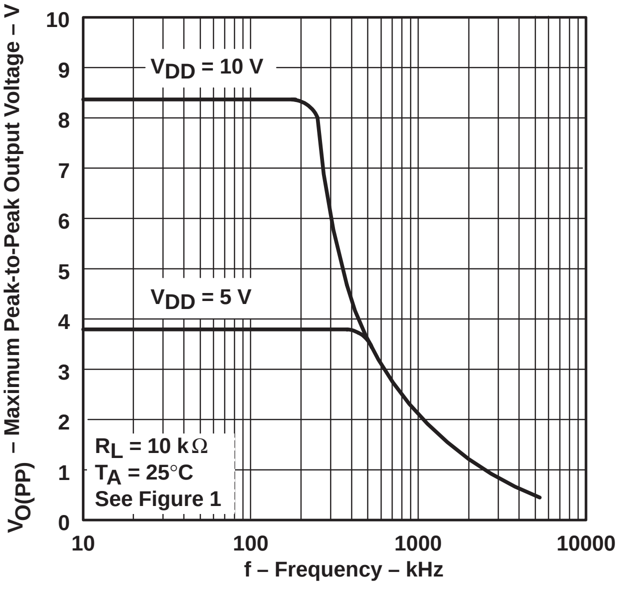


Figure 23

TYPICAL CHARACTERISTICS

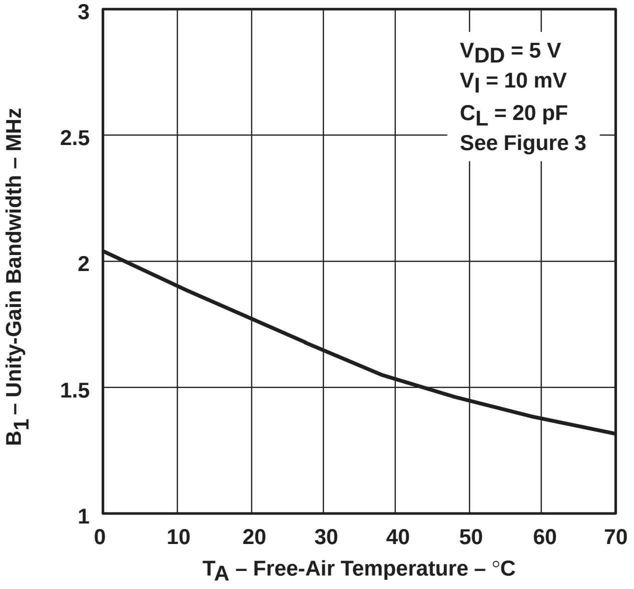

UNITY-GAIN BANDWIDTH
vs
FREE-AIR TEMPERATURE

Figure 24

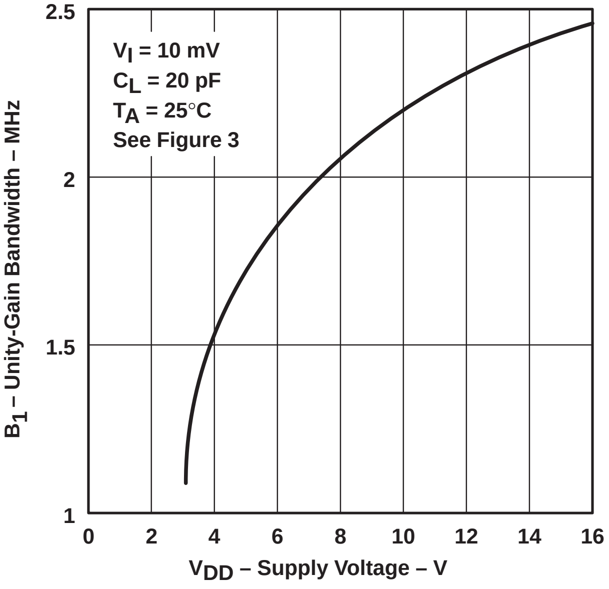

UNITY-GAIN BANDWIDTH
vs
SUPPLY VOLTAGE

Figure 25

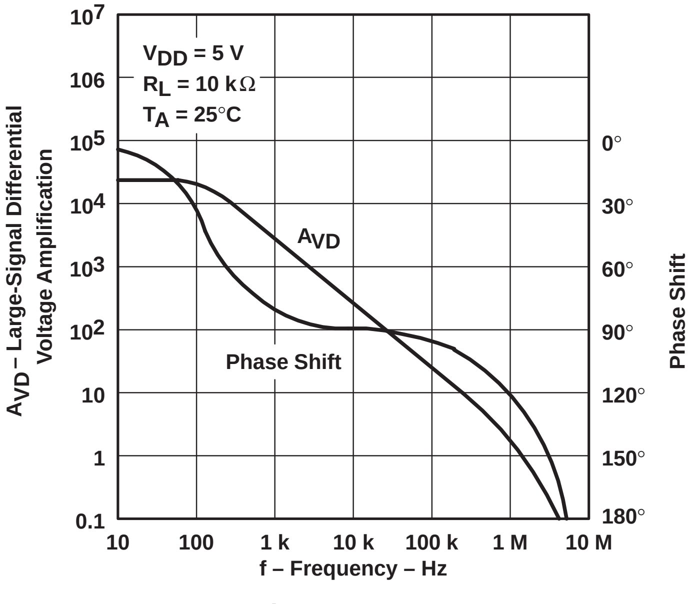

LARGE-SIGNAL DIFFERENTIAL VOLTAGE
AMPLIFICATION AND PHASE SHIFT
vs
FREQUENCY

Figure 26

TYPICAL CHARACTERISTICS

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT vs FREQUENCY

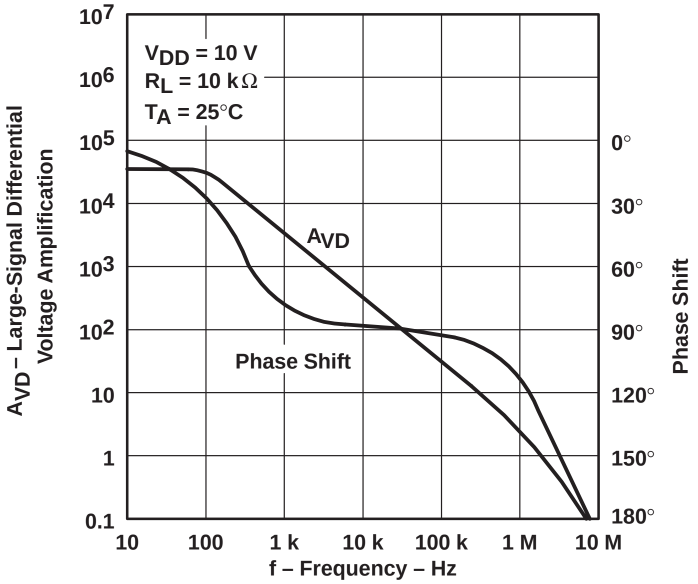


Figure 27

PHASE MARGIN vs SUPPLY VOLTAGE

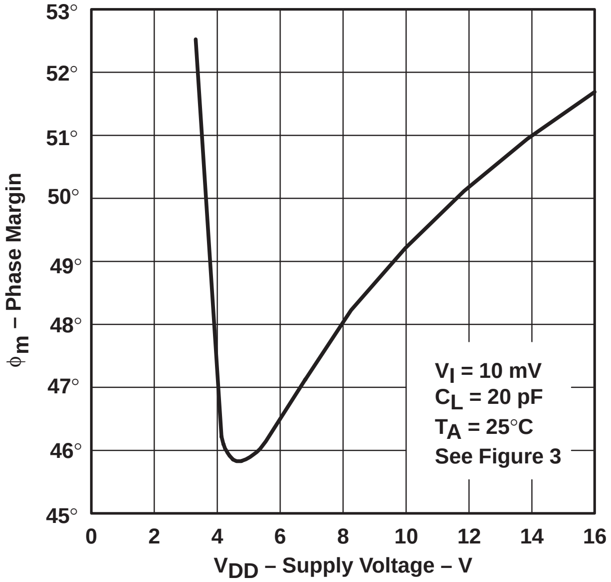


Figure 28

PHASE MARGIN vs FREE-AIR TEMPERATURE

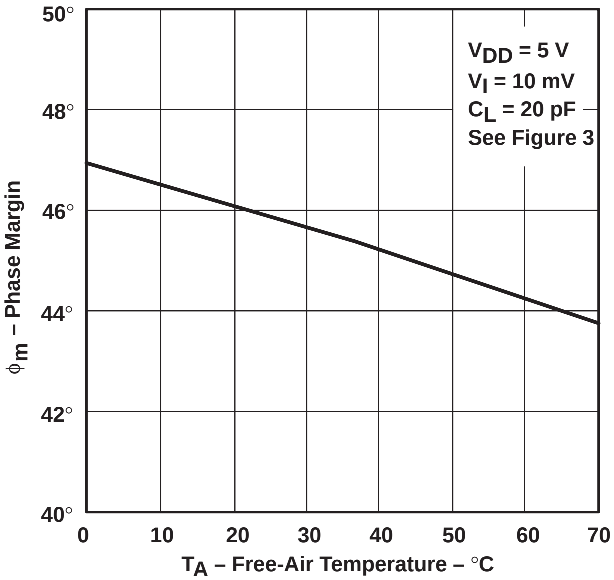


Figure 29

TYPICAL CHARACTERISTICS

PHASE MARGIN
vs
CAPACITIVE LOAD

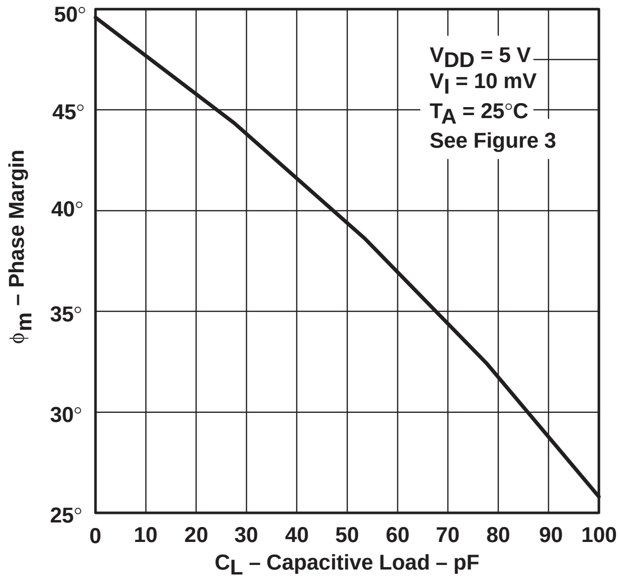


Figure 30

EQUIVALENT INPUT NOISE VOLTAGE
vs
FREQUENCY

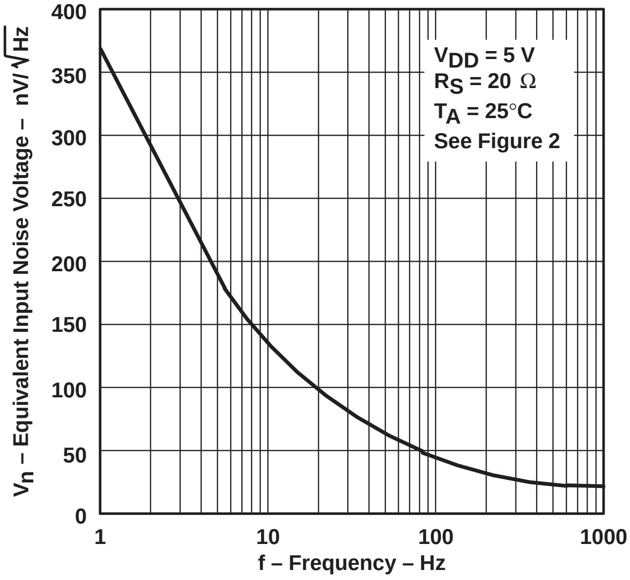


Figure 31

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