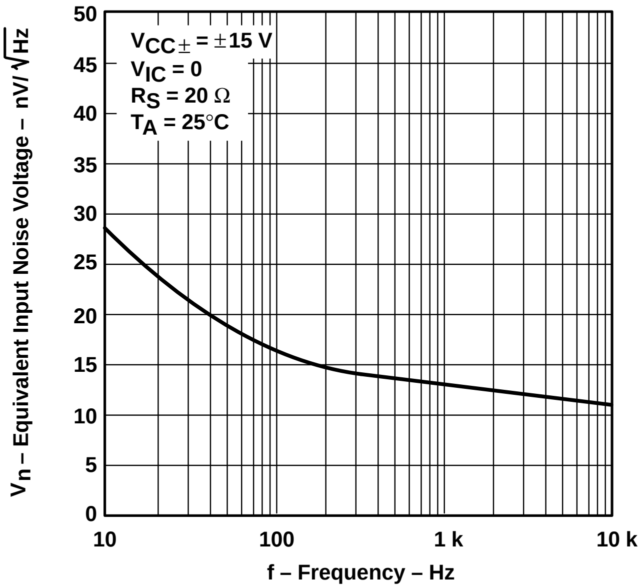
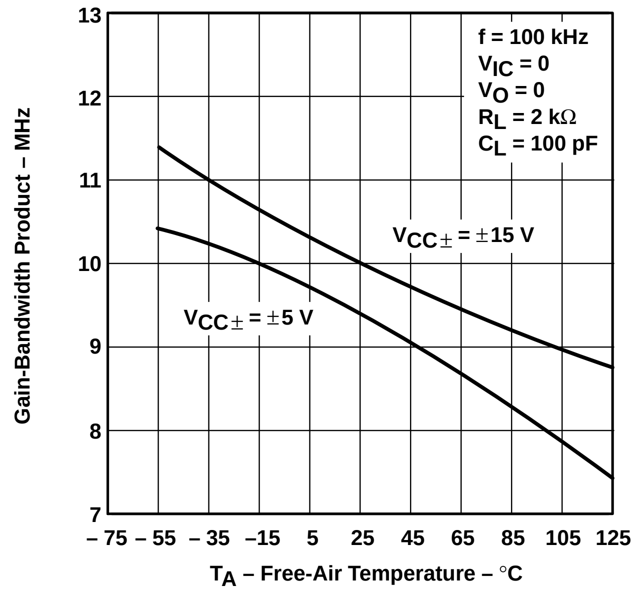
- **40-V/μs Slew Rate Typ**
- **Low Noise**
  17 nV/√Hz Max at f = 10 kHz
  11.6 nV/√Hz Typ at f = 10 kHz
- **High Gain-Bandwidth Product . . . 10 MHz**
- **±30-mA Minimum Short-Circuit Output Current**
- **Wide Supply Range . . . ±2.25 V to ±19 V**
- **Input Range Includes the Positive Supply**
- **Macromodel Included**
- **Fast Settling Time Using 10-V Step**
  400 ns to 10 mV Typ
  1.5 μs to 1 mV Typ

EQUIVALENT INPUT NOISE VOLTAGE
vs
FREQUENCY



GAIN-BANDWIDTH PRODUCT
vs
FREE-AIR TEMPERATURE



description

The TLE2072 and TLE2072A are low-noise, high-performance, internally compensated JFET-input dual operational amplifiers built using Texas Instruments complementary bipolar Excalibur process. These devices combine low noise with outstanding output drive capability, high slew rate, and wide bandwidth.

AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES				CHIP FORM (Y)
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	
0°C to 70°C	3.5 mV 6 mV	TLE2072ACD TLE2072CD	—	—	TLE2072ACP TLE2072CP	— TLE2072Y
−40°C to 85°C	3.5 mV 6 mV	TLE2072AID TLE2072ID	—	—	TLE2072AIP TLE2072IP	—
−55°C to 125°C	3.5 mV 6 mV	—	TLE2072AMFK TLE2072MFK	TLE2072AMJG TLE2072MJG	—	—

The D packages are available taped and reeled. Add R suffix to device type (e.g., TLE2072ACDR). Chip-form versions are tested at T_A = 25°C. For chip-form orders, contact your local TI sales office.

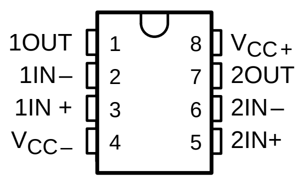
description (continued)

The design features a 28-V/μs minimum slew rate, which results in a high-power bandwidth. A low audio-band noise of 28 nV/√Hz is typical with a 55 nV/√Hz maximum at 10 Hz. Settling time to 0.1% of a 10-V step (1-kΩ/100-pF load) is approximately 400 ns. Gain-bandwidth product is typically 10 MHz with an 8 MHz minimum. As such, the TLE2072 and TLE2072A offer significant speed and noise advantages at a low 1.5-mA typical supply current per channel.

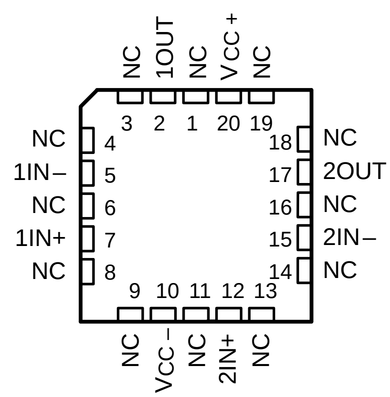
The input current characteristics traditionally associated with JFET-input amplifiers have been maintained. Input offset voltage is graded to a 6 mV and 3.5 mV maximum for the TLE2072 and TLE2072A, respectively. Typically, temperature coefficient of input offset voltage is 2.4 μV/°C and typical CMRR and k_{SVR} are 98 dB and 99 dB, respectively. Device performance is relatively independent of supply voltage over the wide ±2.25-V to ±19-V range. The input common-mode voltage range extends from the positive supply down to V_{CC-} + 4 V without significant degradation to dynamic performance. Maximum peak output voltage swing is from V_{CC+} – 1 V to V_{CC-} + 1 V under light current loading conditions. The output is capable of sourcing and sinking currents to at least 30 mA and can sustain shorts to either supply. Care must be taken to ensure that maximum power dissipation is not exceeded.

Both the TLE2072 and TLE2072A are available in a wide variety of packages, including both the industry-standard 8-pin small-outline version and chip form for high-density system applications. The C-suffix devices are characterized for operation from 0°C to 70°C, the I-suffix devices over the –40°C to 85°C range, and the M-suffix devices over the full military temperature range of –55°C to 125°C.

D, JG, OR P PACKAGE
(TOP VIEW)

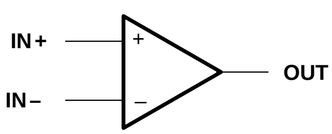


FK PACKAGE
(TOP VIEW)



NC – No internal connection

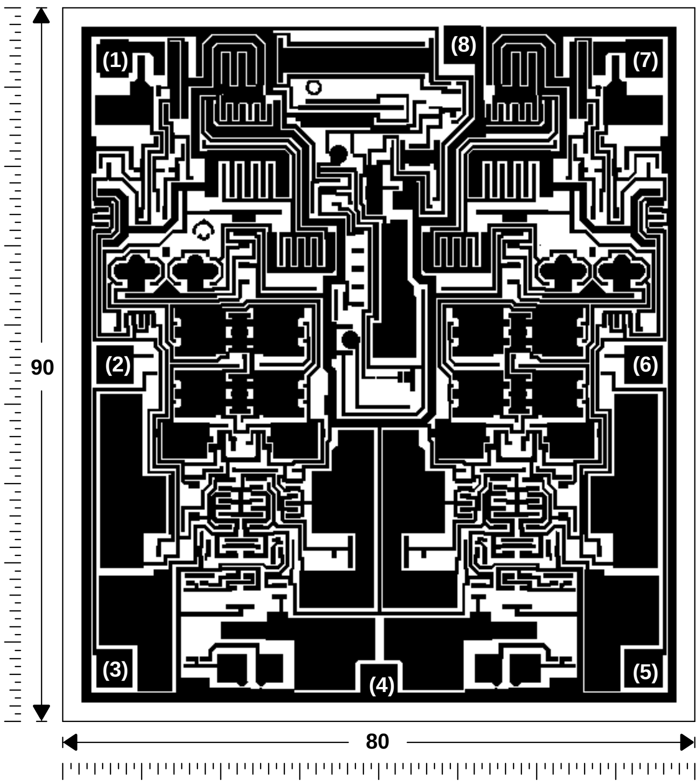
symbol

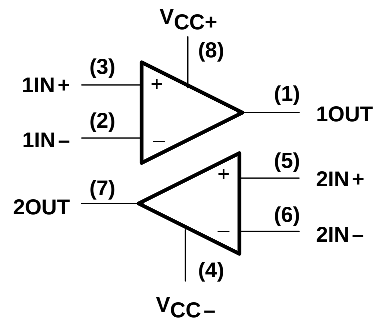


TLE2072Y chip information

This chip, when properly assembled, displays characteristics similar to the TLE2072. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS: 15 TYPICAL

BONDING PADS: 4 × 4 MINIMUM

$T_J$max = 150°C

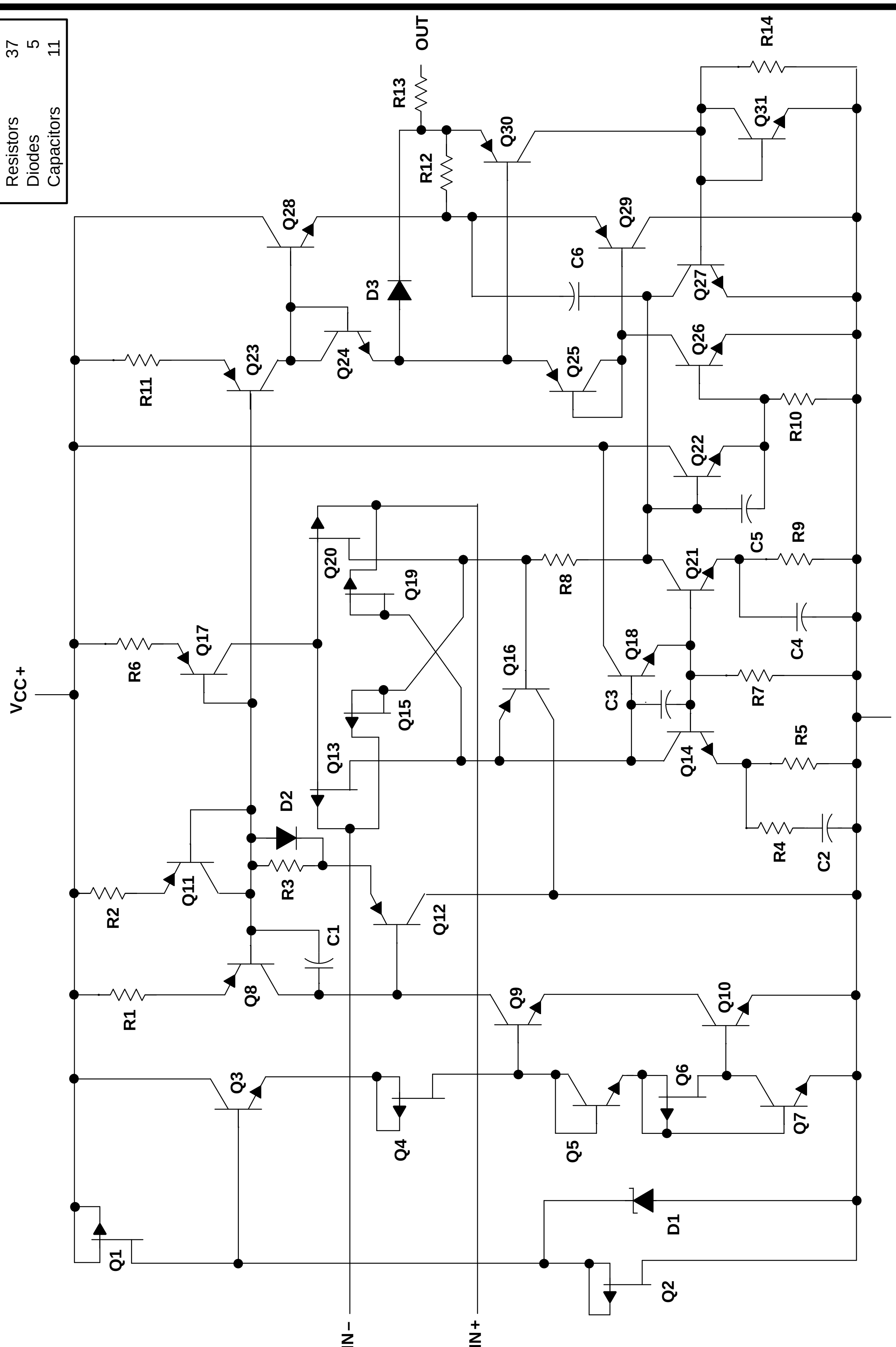
TOLERANCES ARE ±10%.

ALL DIMENSIONS ARE IN MILS.

PIN (4) IS INTERNALLY CONNECTED TO BACKSIDE OF THE CHIP.

equivalent schematic (each channel)

ACTUAL DEVICE COMPONENT COUNT	
Transistors	57
Resistors	37
Diodes	5
Capacitors	11



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

Supply voltage, V_{CC+} (see Note 1) .... 19 V
Supply voltage, V_{CC-} (see Note 1) .... –19 V
Differential input voltage range, V_{ID} (see Note 2) .... V_{CC+} to V_{CC-}
Input voltage range, V_I (any input) .... V_{CC+} to V_{CC-}
Input current, I_I (each input) .... ±1 mA
Output current, I_O (each output) .... ±80 mA
Total current into V_{CC+} .... 160 mA
Total current out of V_{CC-} .... 160 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
Case temperature for 60 seconds: FK package .... 260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or P package .... 260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG 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_{CC+} and V_{CC-}.
2. Differential voltages are at IN+ with respect to IN–.
3. The output can be shorted to either supply. Temperatures and/or supply voltages must be limited to ensure that the maximum dissipation rate is not exceeded.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE T_A = 25°C	T_A = 70°C POWER RATING	T_A = 85°C POWER RATING	T_A = 125°C POWER RATING
D	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
P	1000 mW	8.0 mW/°C	640 mW	344 mW	200 mW

recommended operating conditions

		C SUFFIX		I SUFFIX		M SUFFIX		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{CC\pm}$		±2.25	±19	±2.25	±19	±2.25	±19	V
Common-mode input voltage, V_{IC}	$V_{CC\pm}$ = ±5 V	–0.9	5	–0.8	5	–0.8	5	V
	$V_{CC\pm}$ = ±15 V	–10.9	15	–10.8	15	–10.8	15	
Operating free-air temperature, T_A		0	70	–40	85	–55	125	°C

electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072C			TLE2072AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$		25°C		0.9	6		0.65	3.5	mV
				Full range			7.8			5.3	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		2.3	25		2.3	25	µV/°C
I_{IO}	Input offset current	$V_{IC} = 0$, $V_O = 0$, See Figure 4		25°C		5	100		5	100	pA
				Full range			1.4			1.4	nA
I_{IB}	Input bias current			25°C		15	175		15	175	pA
				Full range			5			5	nA
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$		25°C	5 to −1	5 to −1.9		5 to −1	5 to −1.9		V
				Full range	5 to −0.9			5 to −0.9			
V_{OM+}	Maximum positive peak output voltage swing	$I_O = -200\ \mu A$		25°C	3.8	4.1		3.8	4.1		V
				Full range	3.7			3.7			
		$I_O = -2$ mA		25°C	3.5	3.9		3.5	3.9		
				Full range	3.4			3.4			
		$I_O = -20$ mA		25°C	1.5	2.3		1.5	2.3		
				Full range	1.5			1.5			
V_{OM-}	Maximum negative peak output voltage swing	$I_O = 200\ \mu A$		25°C	−3.8	−4.2		−3.8	−4.2		V
				Full range	−3.7			−3.7			
		$I_O = 2$ mA		25°C	−3.5	−4.1		−3.5	−4.1		
				Full range	−3.4			−3.4			
		$I_O = 20$ mA		25°C	−1.5	−2.4		−1.5	−2.4		
				Full range	−1.5			−1.5			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm 2.3$ V	$R_L = 600\ \Omega$	25°C	80	91		80	91		dB
				Full range	79			79			
			$R_L = 2\ k\Omega$	25°C	90	100		90	100		
				Full range	89			89			
			$R_L = 10\ k\Omega$	25°C	95	106		95	106		
				Full range	94			94			
r_i	Input resistance	$V_{IC} = 0$		25°C		10^{12}			10^{12}		Ω
c_i	Input capacitance	$V_{IC} = 0$, See Figure 5	Common mode	25°C		11			11		pF
			Differential	25°C		2.5			2.5		
z_o	Open-loop output impedance	f = 1 MHz		25°C		80			80		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, $V_O = 0$, $R_S = 50\ \Omega$		25°C	70	89		70	89		dB
				Full range	68			68			
k_{SVR}	Supply-voltage rejection ratio($\Delta V_{CC\pm}$ /ΔV_{IO})	$V_{CC\pm} = \pm5$ V to ±15 V, $V_O = 0$, $R_S = 50\ \Omega$		25°C	82	99		82	99		dB
				Full range	80			80			
I_{CC}	Supply current (both channels)	$V_O = 0$,	No load	25°C	2.7	2.9	3.6	2.7	2.9	3.6	mA
				Full range			3.6			3.6	

† Full range is 0°C to 70°C.

electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072C			TLE2072AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
a_x	Crosstalk attenuation	$V_{IC} = 0$,	$R_L = 2$ kΩ	25°C		120			120		dB
I_{OS}	Short-circuit output current	$V_O = 0$	$V_{ID} = 1$ V	25°C		–35			–35		mA
			$V_{ID} = –1$ V			45			45		

operating characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V

PARAMETER		TEST CONDITIONS		T_A†	TLE2072C			TLE2072AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	$V_{O(PP)} = \pm2.3$ V, $A_{VD} = –1$, $C_L = 100$ pF,	$R_L = 2$ kΩ, See Figure 1	25°C		35			35		V/µs
				Full range	22			22			
SR–	Negative slew rate			25°C		38			38		V/µs
				Full range	22			22			
t_s	Settling time	$A_{VD} = –1$, 2-V step, $R_L = 1$ kΩ, $C_L = 100$ pF	To 10 mV	25°C		0.25			0.25		µs
			To 1 mV			0.4			0.4		
V_n	Equivalent input noise voltage	$R_S = 20$ Ω, See Figure 3	f = 10 Hz	25°C		28	55		28	55	nV/√Hz
			f = 10 kHz			11.6	17		11.6	17	
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage		f = 10 Hz to 10 kHz	25°C		6			6		µV
			f = 0.1 Hz to 10 Hz			0.6			0.6		
I_n	Equivalent input noise current	$V_{IC} = 0$,	f = 10 kHz	25°C		2.8			2.8		fA/√Hz
THD + N	Total harmonic distortion plus noise	$V_{O(PP)} = 5$ V, f = 1 kHz, $R_S = 25$ Ω	$A_{VD} = 10$, $R_L = 2$ kΩ,	25°C		0.013%			0.013%		
B_1	Unity-gain bandwidth	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2$ kΩ, See Figure 2	25°C		9.4			9.4		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 4$ V, $R_L = 2$ kΩ ,	$A_{VD} = –1$, $C_L = 25$ pF	25°C		2.8			2.8		MHz
ϕ_m	Phase margin at unity gain	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2$ kΩ, See Figure 2	25°C		56°			56°		

† Full range is 0°C to 70°C.

electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm 15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072C			TLE2072AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$		25°C		1.1	6		0.7	3.5	mV
				Full range			7.8			5.3	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		2.4	25		2.4	25	µV/°C
I_{IO}	Input offset current	$V_{IC} = 0$, $V_O = 0$, See Figure 4		25°C		6	100		6	100	pA
				Full range			1.4			1.4	nA
I_{IB}	Input bias current			25°C		20	175		20	175	pA
				Full range			5			5	nA
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$		25°C	15 to –11	15 to –11.9		15 to –11	15 to –11.9		V
				Full range	15 to –10.9			15 to –10.9			
V_{OM+}	Maximum positive peak output voltage swing	$I_O = -200\ \mu A$		25°C	13.8	14.1		13.8	14.1		V
				Full range	13.6			13.6			
		$I_O = -2$ mA		25°C	13.5	13.9		13.5	13.9		
				Full range	13.4			13.4			
		$I_O = -20$ mA		25°C	11.5	12.3		11.5	12.3		
				Full range	11.5			11.5			
V_{OM-}	Maximum negative peak output voltage swing	$I_O = 200\ \mu A$		25°C	–13.8	–14.2		–13.8	–14.2		V
				Full range	–13.7			–13.7			
		$I_O = 2$ mA		25°C	–13.5	–14		–13.5	–14		
				Full range	–13.4			–13.4			
		$I_O = 20$ mA		25°C	–11.5	–12.4		–11.5	–12.4		
				Full range	–11.5			–11.5			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm 10$ V	$R_L = 600\ \Omega$	25°C	80	96		80	96		dB
				Full range	79			79			
			$R_L = 2\ k\Omega$	25°C	90	109		90	109		
				Full range	89			89			
			$R_L = 10\ k\Omega$	25°C	95	118		95	118		
				Full range	94			94			
r_i	Input resistance	$V_{IC} = 0$		25°C		10^{12}			10^{12}		Ω
c_i	Input capacitance	$V_{IC} = 0$, See Figure 5	Common mode	25°C		7.5			7.5		pF
			Differential	25°C		2.5			2.5		
z_o	Open-loop output impedance	f = 1 MHz		25°C		80			80		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, $V_O = 0$, $R_S = 50\ \Omega$		25°C	80	98		80	98		dB
				Full range	79			79			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm 5$ V to ± 15 V, $V_O = 0$, $R_S = 50\ \Omega$		25°C	82	99		82	99		dB
				Full range	81			81			
I_{CC}	Supply current (both channels)	$V_O = 0$, No load		25°C	2.7	3.1	3.6	2.7	3.1	3.6	mA
				Full range			3.6			3.6	

† Full range is 0°C to 70°C.

electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm15$ V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072C			TLE2072AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
a_x	Crosstalk attenuation	$V_{IC} = 0$,	$R_L = 2$ kΩ	25°C		120			120		dB
I_{OS}	Short-circuit output current	$V_O = 0$	$V_{ID} = 1$ V	25°C	–30	–45		–30	–45		mA
			$V_{ID} = -1$ V		30	48		30	48		

operating characteristics at specified free-air temperature, $V_{CC\pm} = \pm15$ V

PARAMETER		TEST CONDITIONS		T_A†	TLE2072C			TLE2072AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	$V_{O(PP)} = 10$ V, $A_{VD} = -1$, $C_L = 100$ pF,	$R_L = 2$ kΩ, See Figure 1	25°C	28	40		28	40		V/μs
				Full range	25			25			
SR–	Negative slew rate			25°C	30	45		30	45		V/μs
				Full range	25			25			
t_s	Settling time	$A_{VD} = -1$, 10-V step, $R_L = 1$ kΩ, $C_L = 100$ pF	To 10 mV	25°C		0.4			0.4		μs
			To 1 mV			1.5			1.5		
V_n	Equivalent input noise voltage	$R_S = 20$ Ω, See Figure 3	f = 10 Hz	25°C		28	55		28	55	nV/√Hz
			f = 10 kHz			11.6	17		11.6	17	
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage		f = 10 Hz to 10 kHz	25°C		6			6		μV
			f = 0.1 Hz to 10 Hz			0.6			0.6		
I_n	Equivalent input noise current	$V_{IC} = 0$,	f = 10 kHz	25°C		2.8			2.8		fA/√Hz
THD + N	Total harmonic distortion plus noise	$V_{O(PP)} = 20$ V, f = 1 kHz, $R_S = 25$ Ω	$A_{VD} = 10$, $R_L = 2$ kΩ,	25°C		0.008%			0.008%		
B_1	Unity-gain bandwidth	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2$ kΩ, See Figure 2	25°C	8	10		8	10		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 20$ V, $R_L = 2$ kΩ,	$A_{VD} = -1$, $C_L = 25$ pF	25°C	478	637		478	637		kHz
ϕ_m	Phase margin at unity gain	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2$ kΩ, See Figure 2	25°C		57°			57°		

† Full range is 0°C to 70°C.

electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072I MIN	TLE2072I TYP	TLE2072I MAX	TLE2072AI MIN	TLE2072AI TYP	TLE2072AI MAX	UNIT
V_{IO}	Input offset voltage	$V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$,		25°C		0.9	6		0.65	3.5	mV
				Full range			9.1			6.4	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		2.4	25		2.4	25	μV/°C
I_{IO}	Input offset current	$V_{IC} = 0$, $V_O = 0$, See Figure 4		25°C		5	100		5	100	pA
				Full range			5			5	nA
I_{IB}	Input bias current			25°C		15	175		15	175	pA
				Full range			10			10	nA
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$		25°C	5 to –1	5 to –1.9		5 to –1	5 to –1.9		V
				Full range	5 to –0.8			5 to –0.8			
V_{OM+}	Maximum positive peak output voltage swing	$I_O = -200\ \mu A$		25°C	3.8	4.1		3.8	4.1		V
				Full range	3.7			3.7			
		$I_O = -2$ mA		25°C	3.5	3.9		3.5	3.9		
				Full range	3.4			3.4			
		$I_O = -20$ mA		25°C	1.5	2.3		1.5	2.3		
				Full range	1.5			1.5			
V_{OM-}	Maximum negative peak output voltage swing	$I_O = 200\ \mu A$		25°C	–3.8	–4.2		–3.8	–4.2		V
				Full range	–3.7			–3.7			
		$I_O = 2$ mA		25°C	–3.5	–4.1		–3.5	–4.1		
				Full range	–3.4			–3.4			
		$I_O = 20$ mA		25°C	–1.5	–2.4		–1.5	–2.4		
				Full range	–1.5			–1.5			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm 2.3$ V	$R_L = 600\ \Omega$	25°C	80	91		80	91		dB
				Full range	79			79			
			$R_L = 2\ k\Omega$	25°C	90	100		90	100		
				Full range	89			89			
			$R_L = 10\ k\Omega$	25°C	95	106		95	106		
				Full range	94			94			
r_i	Input resistance	$V_{IC} = 0$		25°C		10^{12}			10^{12}		Ω
c_i	Input capacitance	$V_{IC} = 0$, See Figure 5	Common mode	25°C		11			11		pF
			Differential	25°C		2.5			2.5		
z_o	Open-loop output impedance	f = 1 MHz		25°C		80			80		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, $V_O = 0$, $R_S = 50\ \Omega$		25°C	70	89		70	89		dB
				Full range	68			68			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm5$ V to ±15 V, $V_O = 0$, $R_S = 50\ \Omega$		25°C	82	99		82	99		dB
				Full range	80			80			
I_{CC}	Supply current (both channels)	$V_O = 0$, No load		25°C	2.7	2.9	3.6	2.7	2.9	3.6	mA
				Full range			3.6			3.6	

† Full range is –40°C to 85°C.

electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072I			TLE2072AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
a_x	Crosstalk attenuation	$V_{IC} = 0$,	$R_L = 2$ kΩ	25°C		120			120		dB
I_{OS}	Short-circuit output current	$V_O = 0$	$V_{ID} = 1$ V	25°C		–35			–35		mA
			$V_{ID} = -1$ V			45			45		

operating characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V

PARAMETER		TEST CONDITIONS		T_A†	TLE2072I			TLE2072AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	$V_{O(PP)} = \pm2.3$ V, $A_{VD} = -1$, $C_L = 100$ pF,	$R_L = 2$ kΩ, See Figure 1	25°C		35			35		V/μs
				Full range	20			20			
SR–	Negative slew rate			25°C		38			38		V/μs
				Full range	20			20			
t_s	Settling time	$A_{VD} = -1$, 2-V step, $R_L = 1$ kΩ, $C_L = 100$ pF	To 10 mV	25°C		0.25			0.25		μs
			To 1 mV			0.4			0.4		
V_n	Equivalent input noise voltage	$R_S = 20$ Ω, See Figure 3	f = 10 Hz	25°C		28	55		28	55	nV/√Hz
			f = 10 kHz			11.6	17		11.6	17	
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage		f = 10 Hz to 10 kHz	25°C		6			6		μV
			f = 0.1 Hz to 10 Hz			0.6			0.6		
I_n	Equivalent input noise current	$V_{IC} = 0$,	f = 10 kHz	25°C		2.8			2.8		fA/√Hz
THD + N	Total harmonic distortion plus noise	$V_{O(PP)} = 5$ V, f = 1 kHz, $R_S = 25$ Ω	$A_{VD} = 10$, $R_L = 2$ kΩ,	25°C		0.013%			0.013%		
B_1	Unity-gain bandwidth	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2$ kΩ, See Figure 2	25°C		9.4			9.4		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 4$ V, $R_L = 2$ kΩ ,	$A_{VD} = -1$, $C_L = 25$ pF	25°C		2.8			2.8		MHz
ϕ_m	Phase margin at unity gain	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2$ kΩ, See Figure 2	25°C		56°			56°		

† Full range is 40°C to 85°C.

electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm 15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072I			TLE2072AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$,		25°C		1.1	6		0.7	3.5	mV
				Full range			9.1			6.4	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		2.4	25		2.4	25	µV/°C
I_{IO}	Input offset current	$V_{IC} = 0$, $V_O = 0$, See Figure 4		25°C		6	100		6	100	pA
				Full range			5			5	nA
I_{IB}	Input bias current			25°C		20	175		20	175	pA
				Full range			10			10	nA
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$		25°C	15 to –11	15 to –11.9		15 to –11	15 to –11.9		V
				Full range	15 to –10.8			15 to –10.8			
V_{OM+}	Maximum positive peak output voltage swing	$I_O = -200\ \mu A$		25°C	13.8	14.1		13.8	14.1		V
				Full range	13.7			13.7			
		$I_O = -2$ mA		25°C	13.5	13.9		13.5	13.9		
				Full range	13.4			13.4			
		$I_O = -20$ mA		25°C	11.5	12.3		11.5	12.3		
				Full range	11.5			11.5			
V_{OM-}	Maximum negative peak output voltage swing	$I_O = 200\ \mu A$		25°C	–13.8	–14.2		–13.8	–14.2		V
				Full range	–13.7			–13.7			
		$I_O = 2$ mA		25°C	–13.5	–14		–13.5	–14		
				Full range	–13.4			–13.4			
		$I_O = 20$ mA		25°C	–11.5	–12.4		–11.5	–12.4		
				Full range	–11.5			–11.5			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm 10$ V	$R_L = 600\ \Omega$	25°C	80	96		80	96		dB
				Full range	79			79			
			$R_L = 2\ k\Omega$	25°C	90	109		90	109		
				Full range	89			89			
			$R_L = 10\ k\Omega$	25°C	95	118		95	118		
				Full range	94			94			
r_i	Input resistance	$V_{IC} = 0$		25°C		10^{12}			10^{12}		Ω
c_i	Input capacitance	$V_{IC} = 0$, See Figure 5	Common mode	25°C		7.5			7.5		pF
			Differential	25°C		2.5			2.5		
z_o	Open-loop output impedance	f = 1 MHz		25°C		80			80		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, $V_O = 0$, $R_S = 50\ \Omega$		25°C	80	98		80	98		dB
				Full range	79			79			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm 5$ V to ± 15 V, $V_O = 0$, $R_S = 50\ \Omega$		25°C	82	99		82	99		dB
				Full range	80			80			
I_{CC}	Supply current (both channels)	$V_O = 0$, No load		25°C	2.7	3.1	3.6	2.7	3.1	3.6	mA
				Full range			3.6			3.6	

† Full range is –40°C to 85°C.

electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm15$ V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072I			TLE2072AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
a_x	Crosstalk attenuation	$V_{IC} = 0$,	$R_L = 2$ kΩ	25°C		120			120		dB
I_{OS}	Short-circuit output current	$V_O = 0$	$V_{ID} = 1$ V	25°C	–30	–45		–30	–45		mA
			$V_{ID} = -1$ V		30	48		30	48		

operating characteristics at specified free-air temperature, $V_{CC\pm} = \pm15$ V

PARAMETER		TEST CONDITIONS		T_A†	TLE2072I			TLE2072AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	$V_{O(PP)} = \pm10$ V, $A_{VD} = -1$, $C_L = 100$ pF,	$R_L = 2$ kΩ, See Figure 1	25°C	28	40		28	40		V/µs
				Full range	22			22			
SR–	Negative slew rate			25°C	30	45		30	45		V/µs
				Full range	22			22			
t_s	Settling time	$A_{VD} = -1$, 10-V step, $R_L = 1$ kΩ, $C_L = 100$ pF	To 10 mV	25°C		0.4			0.4		µs
			To 1 mV			1.5			1.5		
V_n	Equivalent input noise voltage	$R_S = 20$ Ω, See Figure 3	f = 10 Hz	25°C		28	55		28	55	nV/√Hz
			f = 10 kHz			11.6	17		11.6	17	
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage		f = 0 Hz to 10 kHz	25°C		6			6		µV
			f = 0.1 Hz to 10 Hz			0.6			0.6		
I_n	Equivalent input noise current	$V_{IC} = 0$,	f = 10 kHz	25°C		2.8			2.8		fA/√Hz
THD + N	Total harmonic distortion plus noise	$V_{O(PP)} = 20$ V, f = 1 kHz, $R_S = 25$ Ω	$A_{VD} = 10$, $R_L = 2$ kΩ,	25°C		0.008%			0.008%		
B_1	Unity-gain bandwidth	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2$ kΩ, See Figure 2	25°C	8	10		8	10		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 20$ V, $R_L = 2$ kΩ,	$A_{VD} = -1$, $C_L = 25$ pF	25°C	478	637		478	637		kHz
ϕ_m	Phase margin at unity gain	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2$ kΩ, See Figure 2	25°C		57°			57°		

† Full range is –40°C to 85°C.

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

PARAMETER		TEST CONDITIONS		T_A†	TLE2072M MIN	TLE2072M TYP	TLE2072M MAX	TLE2072AM MIN	TLE2072AM TYP	TLE2072AM MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0, V_O = 0, R_S = 50 Ω,		25°C		0.9	6		0.65	3.5	mV
				Full range			10.5			8	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		2.3	25*		2.3	25*	μV/°C
I_{IO}	Input offset current	V_{IC} = 0, V_O = 0, See Figure 4		25°C		5	100		5	100	pA
				Full range			20			20	nA
I_{IB}	Input bias current			25°C		15	175		15	175	pA
				Full range			65			65	nA
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω		25°C	5 to −1	5 to −1.9		5 to −1	5 to −1.9		V
				Full range	5 to −0.8			5 to −0.8			
V_{OM+}	Maximum positive peak output voltage swing	I_O = −200 μA		25°C	3.8	4.1		3.8	4.1		V
				Full range	3.6			3.6			
		I_O = −2 mA		25°C	3.5	3.9		3.5	3.9		
				Full range	3.3			3.3			
		I_O = −20 mA		25°C	1.5	2.3		1.5	2.3		
				Full range	1.4			1.4			
V_{OM-}	Maximum negative peak output voltage swing	I_O = 200 μA		25°C	−3.8	−4.2		−3.8	−4.2		V
				Full range	−3.6			−3.6			
		I_O = 2 mA		25°C	−3.5	−4.1		−3.5	−4.1		
				Full range	−3.3			−3.3			
		I_O = 20 mA		25°C	−1.5	−2.4		−1.5	−2.4		
				Full range	−1.4			−1.4			
A_{VD}	Large-signal differential voltage amplification	V_O = ± 2.3 V	R_L = 600 Ω	25°C	80	91		80	91		dB
				Full range	78			78			
			R_L = 2 kΩ	25°C	90	100		90	100		
				Full range	88			88			
			R_L = 10 kΩ	25°C	95	106		95	106		
				Full range	93			93			
r_i	Input resistance	V_{IC} = 0		25°C		10^{12}			10^{12}		Ω
c_i	Input capacitance	V_{IC} = 0, See Figure 5	Common mode	25°C		11			11		pF
			Differential	25°C		2.5			2.5		
z_o	Open-loop output impedance	f = 1 MHz		25°C		80			80		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, V_O = 0, R_S = 50 Ω		25°C	70	89		70	89		dB
				Full range	68			68			

*On products compliant to MIL-STD-883, Class B, this parameter is not production tested.
† Full range is −55°C to 125°C.

electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072M			TLE2072AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm} / \Delta V_{IO}$)	$V_{CC\pm} = \pm5$ V to ±15 V, $V_O = 0$,	$R_S = 50\ \Omega$	Full range	80			80			dB
I_{CC}	Supply current (both channels)	$V_O = 0$,	No load	25°C	2.7	2.9	3.6	2.7	2.9	3.6	mA
				Full range			3.6			3.6	
a_x	Crosstalk attenuation	$V_{IC} = 0$,	$R_L = 2\ k\Omega$	25°C		120			120		dB
I_{OS}	Short-circuit output current	$V_O = 0$	$V_{ID} = 1$ V	25°C		–35			–35		mA
			$V_{ID} = -1$ V			45			45		

operating characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V

PARAMETER		TEST CONDITIONS		T_A†	TLE2072M			TLE2072AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	$V_{O(PP)} = \pm2.3$ V, $A_{VD} = -1$, $C_L = 100$ pF,	$R_L = 2\ k\Omega$, See Figure 1	25°C		35			35		V/μs
				Full range	18*			18*			
SR–	Negative slew rate			25°C		38			38		V/μs
				Full range	18*			18*			
t_s	Settling time	$A_{VD} = -1$, 2-V step, $R_L = 1\ k\Omega$, $C_L = 100$ pF	To 10 mV	25°C		0.25			0.25		μs
			To 1 mV			0.4			0.4		
V_n	Equivalent input noise voltage	$R_S = 20\ \Omega$, See Figure 3	f = 10 Hz	25°C		28	55*		28	55*	$nV/\sqrt{Hz}$
			f = 10 kHz			11.6	17*		11.6	17*	
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage		f = 10 Hz to 10 kHz	25°C		6			6		μV
			f = 0.1 Hz to 10 Hz			0.6			0.6		
I_n	Equivalent input noise current	$V_{IC} = 0$,	f = 10 kHz	25°C		2.8			2.8		$fA/\sqrt{Hz}$
THD + N	Total harmonic distortion plus noise	$V_{O(PP)} = 5$ V, f = 1 kHz, $R_S = 25\ \Omega$	$A_{VD} = 10$, $R_L = 2\ k\Omega$,	25°C		0.013%			0.013%		
B_1	Unity-gain bandwidth	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2\ k\Omega$, See Figure 2	25°C		9.4			9.4		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 4$ V, $R_L = 2\ k\Omega$,	$A_{VD} = -1$, $C_L = 25$ pF	25°C		2.8			2.8		MHz
ϕ_m	Phase margin at unity gain	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2\ k\Omega$, See Figure 2	25°C		56°			56°		

*On products compliant to MIL-STD-883, Class B, this parameter is not production tested.
† Full range is –55°C to 125°C.

electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072M MIN	TLE2072M TYP	TLE2072M MAX	TLE2072AM MIN	TLE2072AM TYP	TLE2072AM MAX	UNIT
V_{IO}	Input offset voltage	$V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$		25°C		1.1	6		0.7	3.5	mV
				Full range			10.5			8	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		2.4	25*		2.4	25*	µV/°C
I_{IO}	Input offset current	$V_{IC} = 0$, $V_O = 0$, See Figure 4		25°C		6	100		6	100	pA
				Full range			20			20	nA
I_{IB}	Input bias current			25°C		20	175		20	175	pA
				Full range			65			65	nA
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$		25°C	15 to –11	15 to –11.9		15 to –11	15 to –11.9		V
				Full range	15 to –10.8			15 to –10.8			
V_{OM+}	Maximum positive peak output voltage swing	$I_O = -200\ \mu A$		25°C	13.8	14.1		13.8	14.1		V
				Full range	13.6			13.6			
		$I_O = -2$ mA		25°C	13.5	13.9		13.5	13.9		
				Full range	13.3			13.3			
		$I_O = -20$ mA		25°C	11.5	12.3		11.5	12.3		
				Full range	11.4			11.4			
V_{OM-}	Maximum negative peak output voltage swing	$I_O = 200\ \mu A$		25°C	–13.8	–14.2		–13.8	–14.2		V
				Full range	–13.6			–13.6			
		$I_O = 2$ mA		25°C	–13.5	–14		–13.5	–14		
				Full range	–13.3			–13.3			
		$I_O = 20$ mA		25°C	–11.5	–12.4		–11.5	–12.4		
				Full range	–11.4			–11.4			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm10$ V	$R_L = 600\ \Omega$	25°C	80	96		80	96		dB
				Full range	78			78			
			$R_L = 2\ k\Omega$	25°C	90	109		90	109		
				Full range	89			89			
			$R_L = 10\ k\Omega$	25°C	95	118		95	118		
				Full range	93			93			
r_i	Input resistance	$V_{IC} = 0$		25°C		10^{12}			10^{12}		Ω
c_i	Input capacitance	$V_{IC} = 0$, See Figure 5	Common mode	25°C		7.5			7.5		pF
			Differential	25°C		2.5			2.5		
z_o	Open-loop output impedance	f = 1 MHz		25°C		80			80		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, $V_O = 0$, $R_S = 50\ \Omega$		25°C	80	98		80	98		dB
				Full range	78			78			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm5$ V to ±15 V, $V_O = 0$, $R_S = 50\ \Omega$		25°C	82	99		82	99		dB
				Full range	80			80			

*On products compliant to MIL-STD-883, Class B, this parameter is not production tested.
† Full range is –55°C to 125°C.

electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm 15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072M			TLE2072AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
I_{CC}	Supply current (both channels)	$V_O = 0$,	No load	25°C	2.7	3.1	3.6	2.7	3.1	3.6	mA
				Full range			3.6			3.6	
a_x	Crosstalk attenuation	$V_{IC} = 0$,	$R_L = 2$ kΩ	25°C		120			120		dB
I_{OS}	Short-circuit output current	$V_O = 0$	$V_{ID} = 1$ V	25°C	–30	–45		–30	–45		mA
			$V_{ID} = -1$ V		30	48		30	48		

operating characteristics at specified free-air temperature, $V_{CC\pm} = \pm 15$ V

PARAMETER		TEST CONDITIONS		T_A†	TLE2072M			TLE2072AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	$V_{O(PP)} = 10$ V, $R_L = 2$ kΩ, See Figure 1	$A_{VD} = -1$, $C_L = 100$ pF,	25°C	28	40		28	40		V/µs
				Full range	20			20			
SR–	Negative slew rate			25°C	30	45		30	45		V/µs
				Full range	20			20			
t_s	Settling time	$A_{VD} = -1$, 10-V step, $R_L = 1$ kΩ, $C_L = 100$ pF	To 10 mV	25°C		0.4			0.4		µs
			To 1 mV			1.5			1.5		
V_n	Equivalent input noise voltage	$R_S = 20$ Ω, See Figure 3	f = 10 Hz	25°C		28	55*		28	55*	nV/√Hz
			f = 10 kHz			11.6	17*		11.6	17*	
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage		f = 10 Hz to 10 kHz	25°C		6			6		µV
			f = 0.1 Hz to 10 Hz			0.6			0.6		
I_n	Equivalent input noise current	$V_{IC} = 0$,	f = 10 kHz	25°C		2.8			2.8		fA/√Hz
THD + N	Total harmonic distortion plus noise	$V_{O(PP)} = 20$ V, f = 1 kHz, $R_S = 25$ Ω	$A_{VD} = 10$, $R_L = 2$ kΩ,	25°C		0.008%			0.008%		
B_1	Unity-gain bandwidth	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2$ kΩ, See Figure 2	25°C	8*	10		8*	10		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 20$ V, $R_L = 2$ kΩ,	$A_{VD} = -1$, $C_L = 25$ pF	25°C	478*	637		478*	637		kHz
ϕ_m	Phase margin at unity gain	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2$ kΩ, See Figure 2	25°C		57°			57°		

*On products compliant to MIL-STD-883, Class B, this parameter is not production tested.
† Full range is –55°C to 125°C.

electrical characteristics at $V_{CC\pm} = \pm15$ V, $T_A = 25°C$

PARAMETER		TEST CONDITIONS		TLE2072Y			UNIT
				MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$			1.1	6	mV
I_{IO}	Input offset current	$V_{IC} = 0$, $V_O = 0$, See Figure 4			6	100	pA
I_{IB}	Input bias current				20	175	pA
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$		15 to −11	15 to 11.9		V
V_{OM+}	Maximum positive peak output voltage swing	$I_O = -200\ \mu A$		13.8	14.1		V
		$I_O = -2$ mA		13.5	13.9		
		$I_O = -20$ mA		11.5	12.3		
V_{OM-}	Maximum negative peak output voltage swing	$I_O = 200\ \mu A$		−13.8	−14.2		V
		$I_O = 2$ mA		−13.5	−14		
		$I_O = 20$ mA		−11.5	−12.4		
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm 10$ V	$R_L = 600\ \Omega$	80	96		dB
			$R_L = 2$ kΩ	90	109		
			$R_L = 10$ kΩ	95	118		
r_i	Input resistance	$V_{IC} = 0$			10^{12}		Ω
c_i	Input capacitance	$V_{IC} = 0$, See Figure 5	Common mode		7.5		pF
			Differential		2.5		
z_o	Open-loop output impedance	f = 1 MHz			80		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, $V_O = 0$, $R_S = 50\ \Omega$		80	98		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm5$ V to ±15 V, $V_O = 0$, $R_S = 50\ \Omega$		82	99		dB
I_{CC}	Supply current (both channels)	$V_O = 0$, No load		2.7	3.1	3.6	mA
I_{OS}	Short-circuit output current	$V_O = 0$	$V_{ID} = 1$ V	−30	−45		mA
			$V_{ID} = -1$ V	30	48		

PARAMETER MEASUREMENT INFORMATION

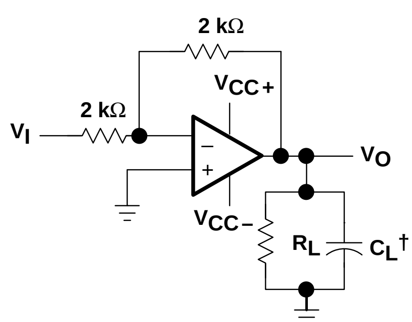


Figure 1. Slew-Rate Test Circuit

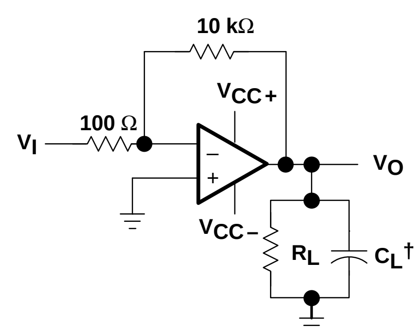


Figure 2. Unity-Gain Bandwidth and Phase-Margin Test Circuit

† Includes fixture capacitance

PARAMETER MEASUREMENT INFORMATION

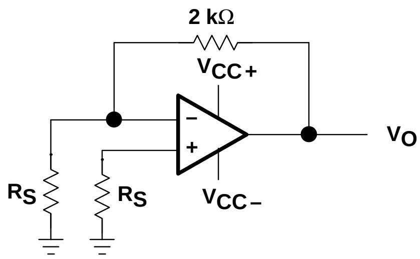


Figure 3. Noise-Voltage Test Circuit

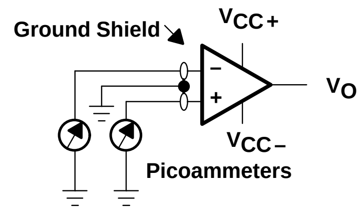


Figure 4. Input-Bias and Offset-Current Test Circuit

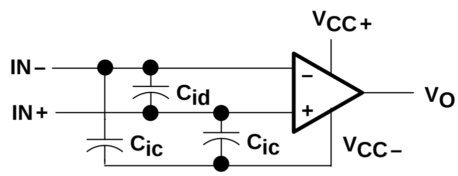


Figure 5. Internal Input Capacitance

typical values

Typical values presented in this data sheet represent the median (50% point) of device parametric performance.

input bias and offset current

At the picoampere bias-current level typical of the TLE2072 and TLE2072A, accurate measurement of the bias becomes difficult. Not only does this measurement require a picoammeter, but test socket leakages can easily exceed the actual device bias currents. To accurately measure these small currents, Texas Instruments uses a two-step process. The socket leakage is measured using picoammeters with bias voltages applied but with no device in the socket. The device is then inserted in the socket and a second test is performed that measures both the socket leakage and the device input bias current. The two measurements are then subtracted algebraically to determine the bias current of the device.

TYPICAL CHARACTERISTICS

Table of Graphs

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V_{IO}	Input offset voltage	Distribution	6
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I_{IB}	Input bias current	vs Free-air temperature vs Supply voltage	8, 9 10
V_{ICR}	Common-mode input voltage range	vs Free-air temperature	11
V_{ID}	Differential input voltage	vs Output voltage	12, 13

TYPICAL CHARACTERISTICS

Table of Graphs (Continued)

			FIGURE
V_{OM+}	Maximum positive peak output voltage	vs Output current vs Free-air temperature vs Supply voltage	14 16, 17 18
V_{OM-}	Maximum negative peak output voltage	vs Output current vs Free-air temperature vs Supply voltage	15 16, 17 18
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency	19
V_O	Output voltage	vs Settling time	20
A_{VD}	Differential voltage amplification	vs Load resistance vs Free-air temperature vs Frequency	21 22, 23 24, 25
CMRR	Common-mode rejection ratio	vs Frequency vs Free-air temperature	26 27
k_{SVR}	Supply-voltage rejection ratio	vs Frequency vs Free-air temperature	28 29
I_{CC}	Supply current	vs Supply voltage vs Free-air temperature vs Differential input voltage	30 31 32, 33
I_{OS}	Short-circuit output current	vs Supply voltage vs Elapsed time vs Free-air temperature	34 35 36
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V_n	Equivalent input noise voltage	vs Frequency	41
V_n	Input-referred noise voltage	vs Noise bandwidth Over a 10-second time interval	42 43
	Third-octave spectral noise density	vs Frequency bands	44
THD + N	Total harmonic distortion plus noise	vs Frequency	45, 46
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	Gain-bandwidth product	vs Free-air temperature vs Supply voltage	48 49
	Gain margin	vs Load capacitance	50
ϕ_m	Phase margin	vs Free-air temperature vs Supply voltage vs Load capacitance	51 52 53
	Phase shift	vs Frequency	24, 25
	Large-signal pulse response, noninverting	vs Time	54
	Small-signal pulse response	vs Time	55
z_o	Closed-loop output impedance	vs Frequency	56
a_x	Crosstalk attenuation	vs Frequency	57

TYPICAL CHARACTERISTICS†

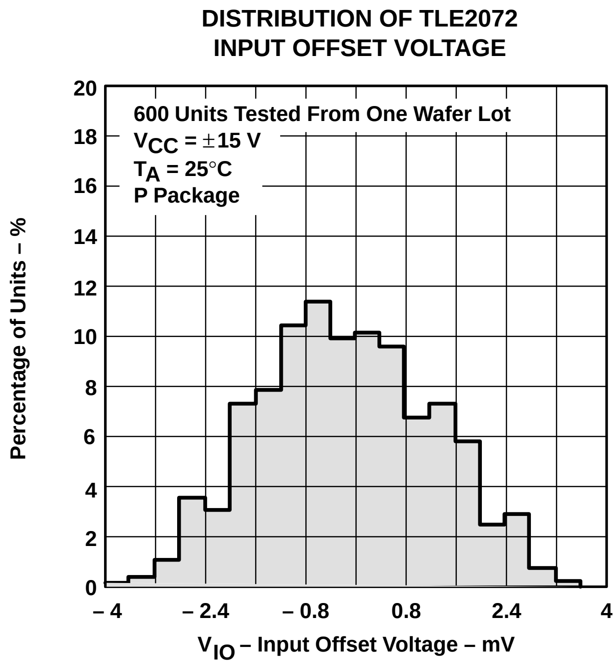


Figure 6

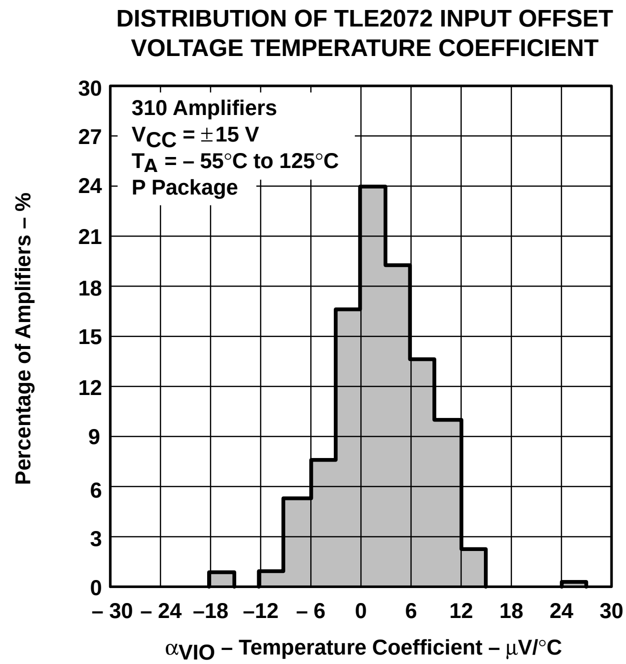


Figure 7

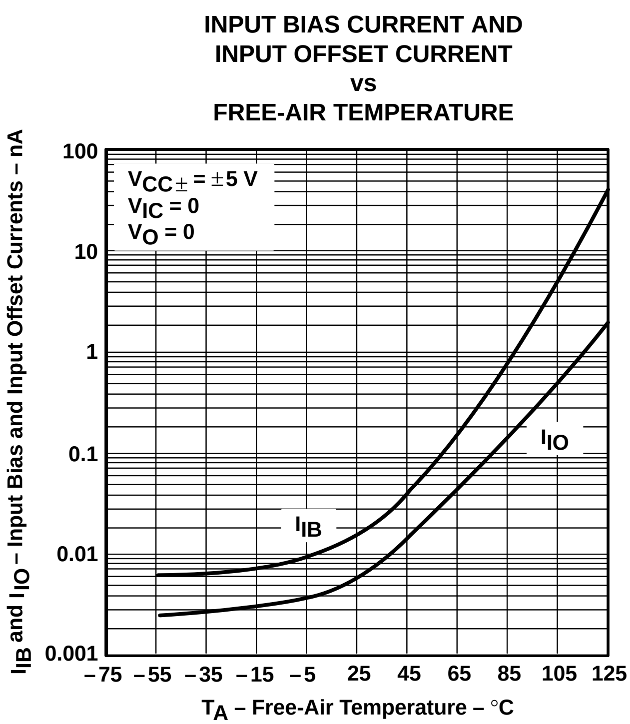


Figure 8

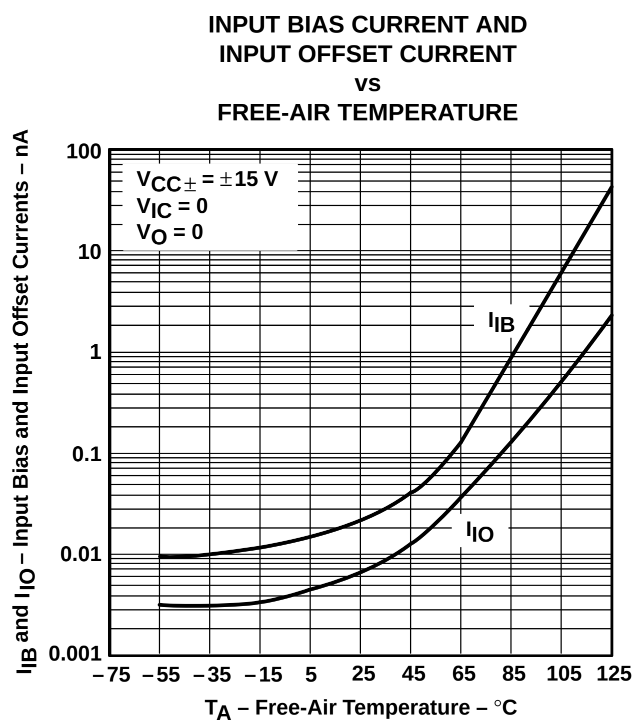


Figure 9

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

TYPICAL CHARACTERISTICS†

INPUT BIAS CURRENT
vs
SUPPLY VOLTAGE

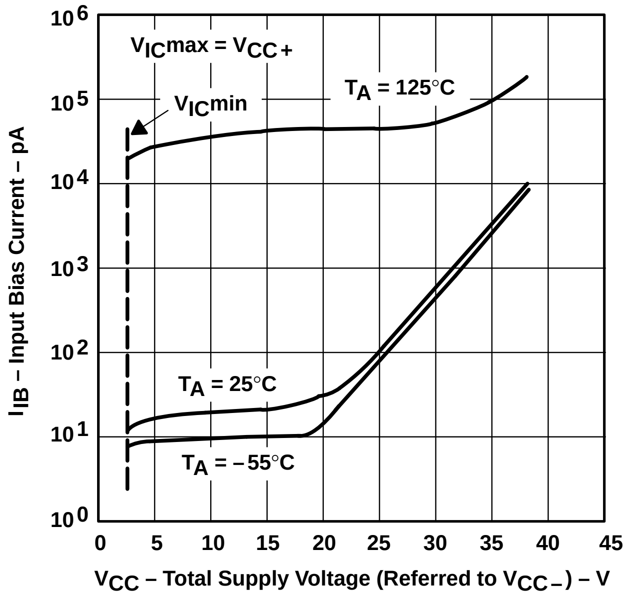


Figure 10

COMMON-MODE INPUT VOLTAGE RANGE
vs
FREE-AIR TEMPERATURE

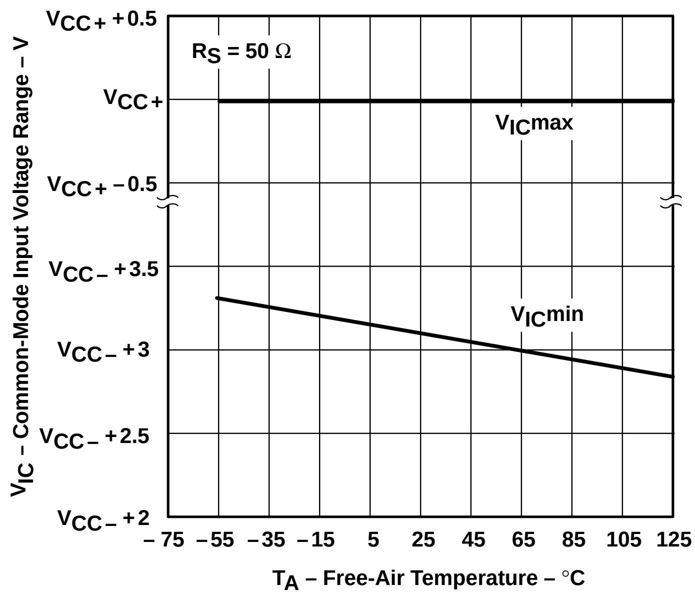


Figure 11

DIFFERENTIAL INPUT VOLTAGE
vs
OUTPUT VOLTAGE

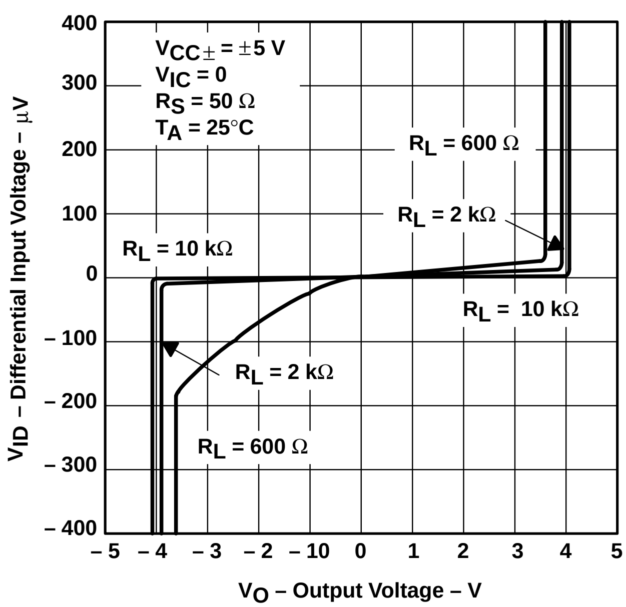


Figure 12

DIFFERENTIAL INPUT VOLTAGE
vs
OUTPUT VOLTAGE

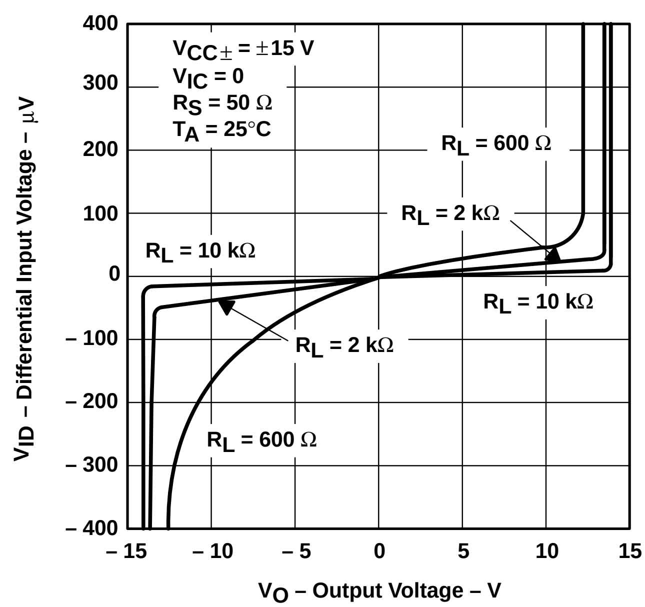


Figure 13

† 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

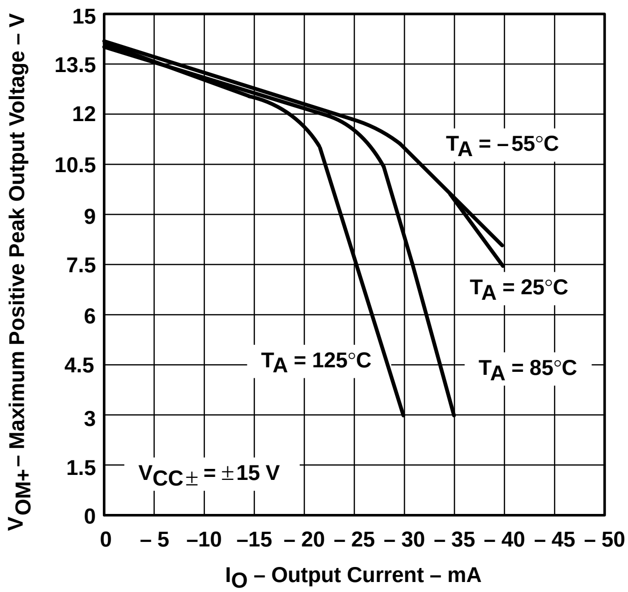


Figure 14

MAXIMUM NEGATIVE PEAK OUTPUT VOLTAGE vs OUTPUT CURRENT

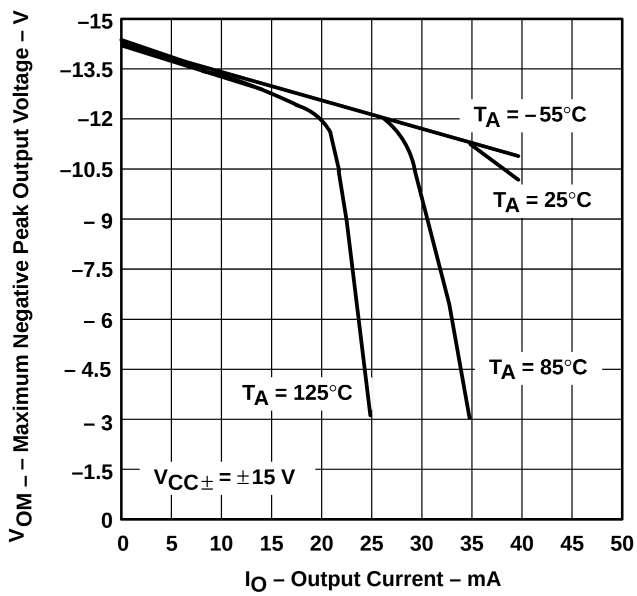


Figure 15

MAXIMUM PEAK OUTPUT VOLTAGE vs FREE-AIR TEMPERATURE

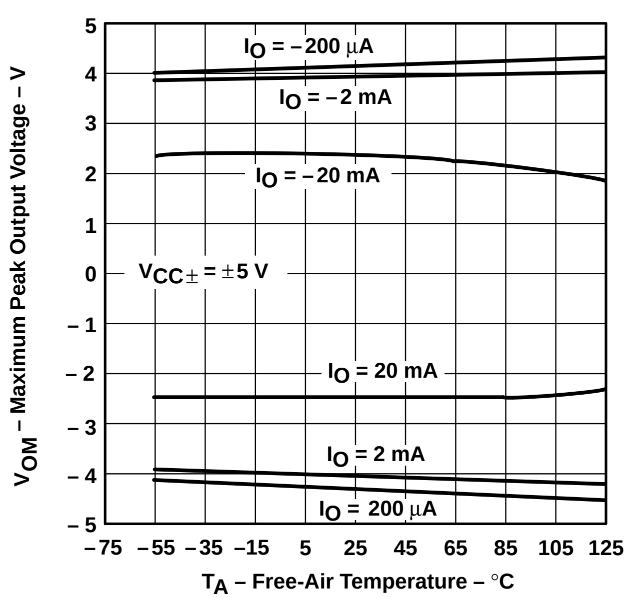


Figure 16

MAXIMUM PEAK OUTPUT VOLTAGE vs FREE-AIR TEMPERATURE

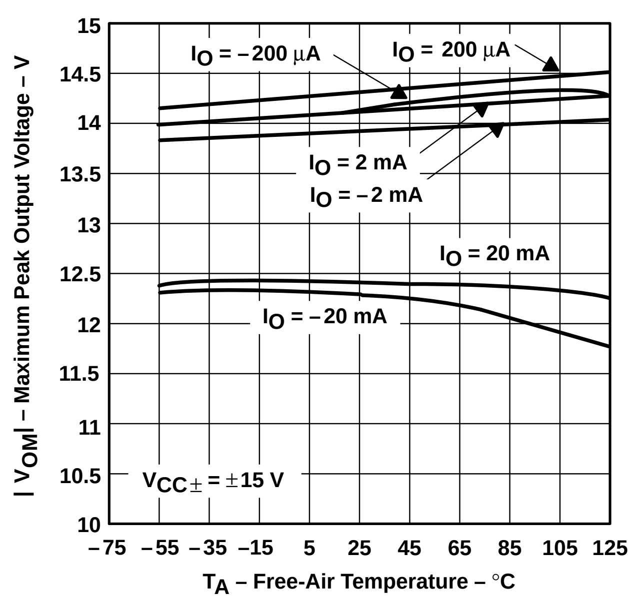


Figure 17

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

TYPICAL CHARACTERISTICS†

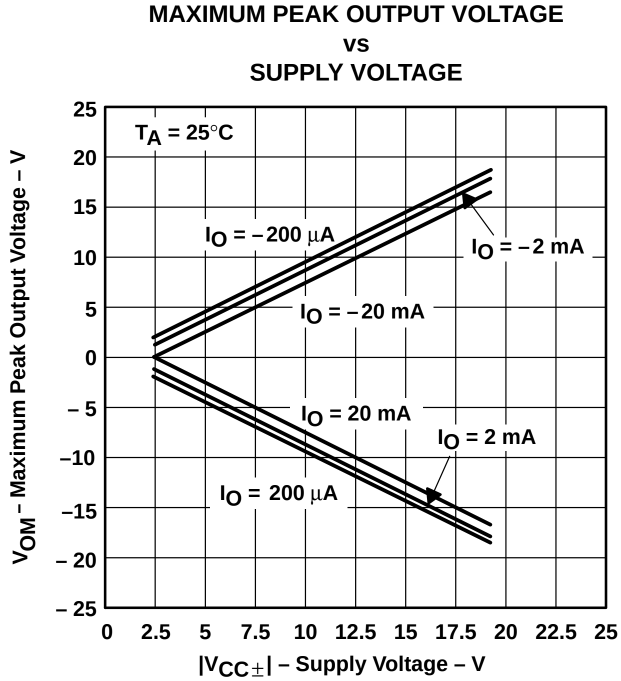


Figure 18

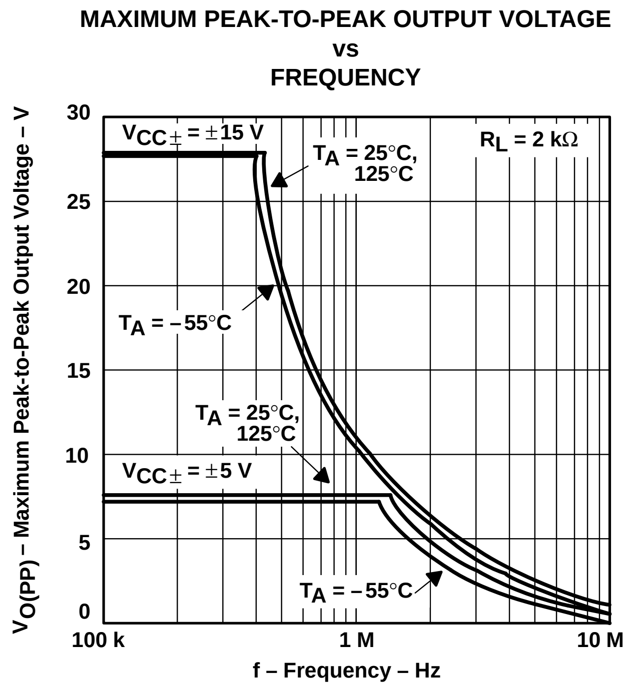


Figure 19

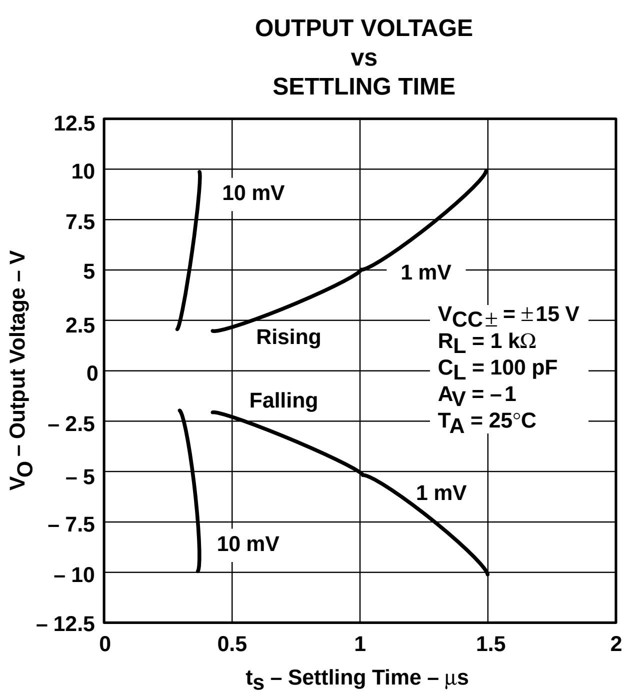


Figure 20

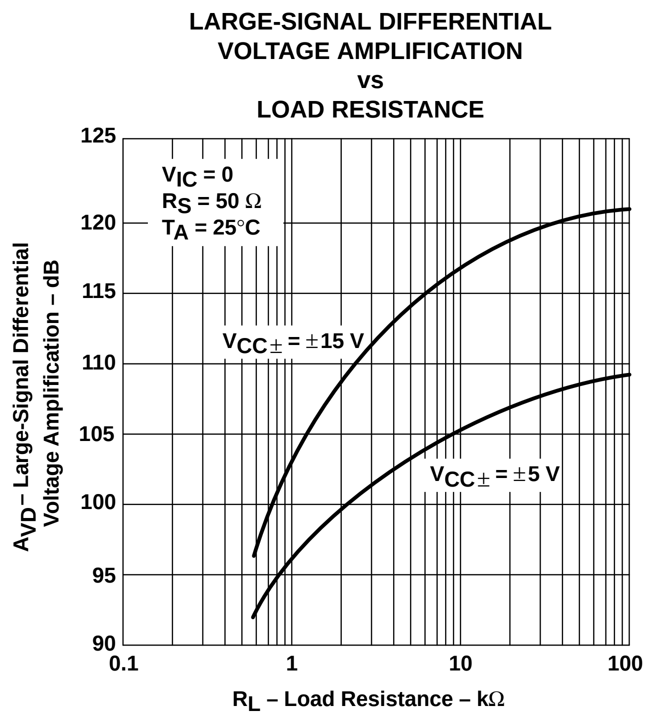


Figure 21

† 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 vs FREE-AIR TEMPERATURE

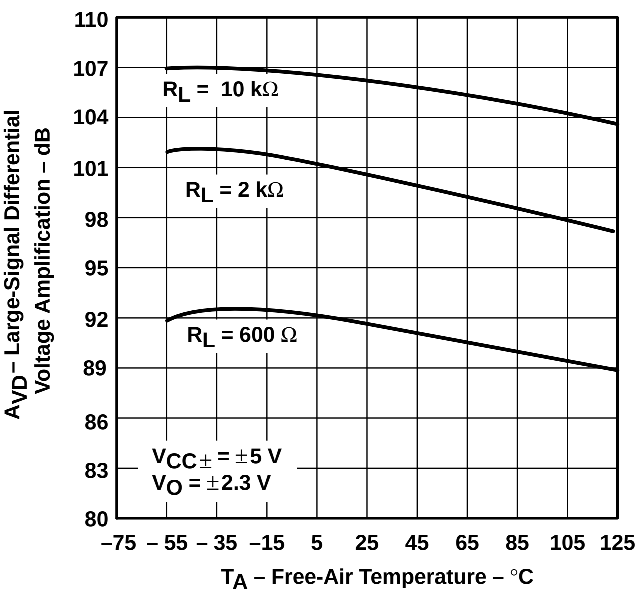


Figure 22

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

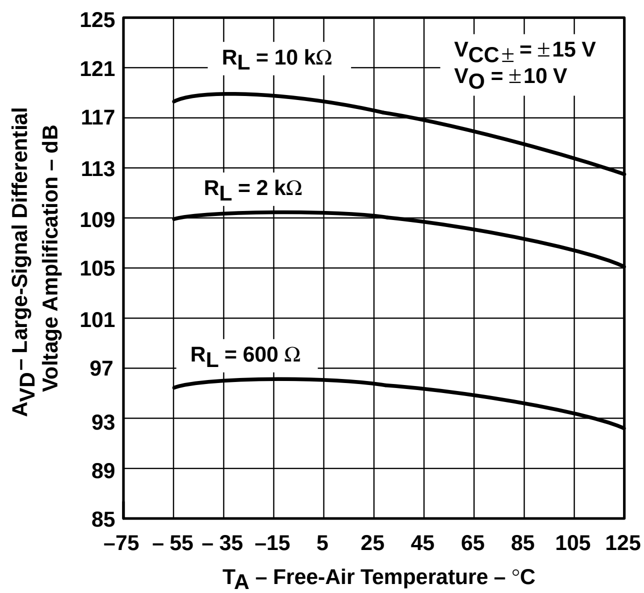


Figure 23

SMALL-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT vs FREQUENCY

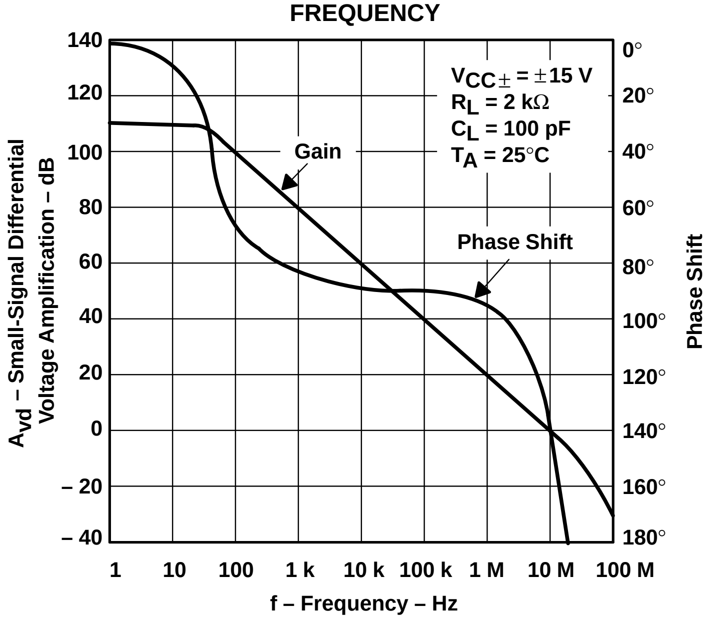


Figure 24

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

TYPICAL CHARACTERISTICS†

SMALL-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT vs FREQUENCY

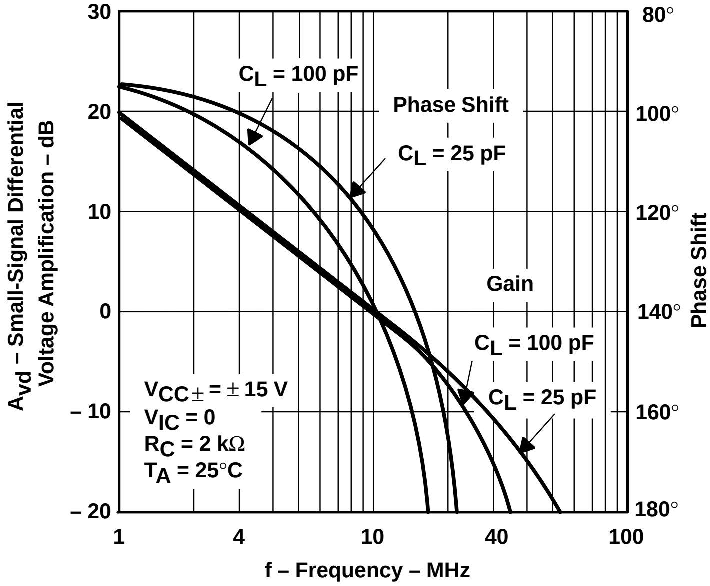


Figure 25

COMMON-MODE REJECTION RATIO vs FREQUENCY

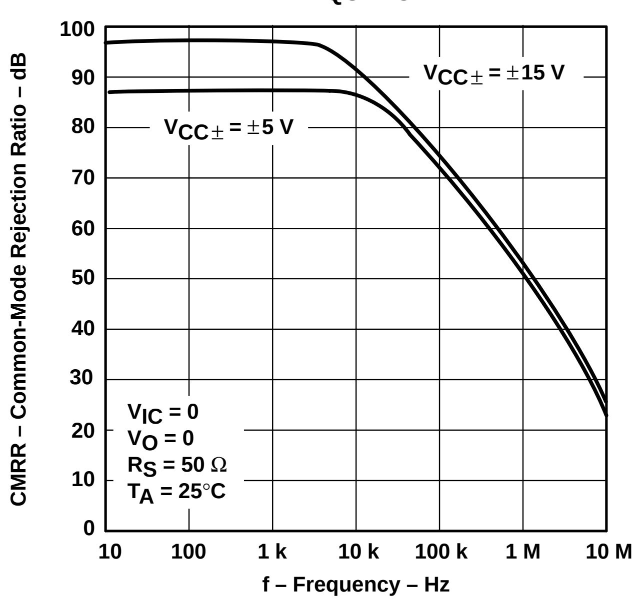


Figure 26

COMMON-MODE REJECTION RATIO vs FREE-AIR TEMPERATURE

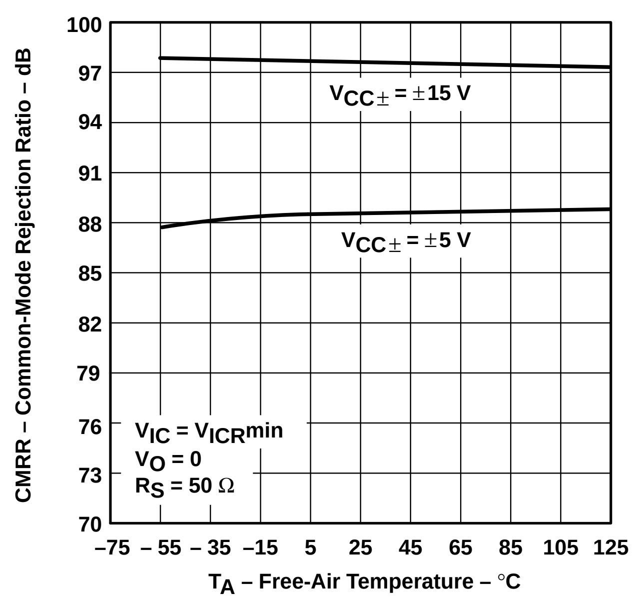


Figure 27

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

TYPICAL CHARACTERISTICS†

SUPPLY-VOLTAGE REJECTION RATIO vs FREQUENCY

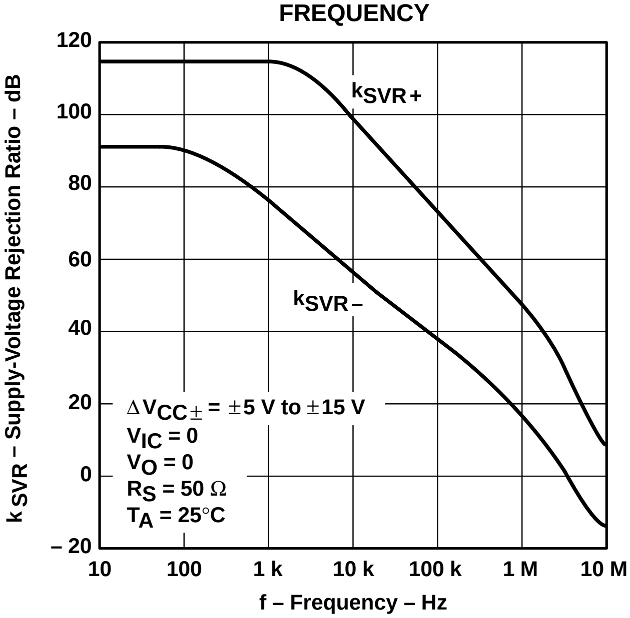


Figure 28

SUPPLY-VOLTAGE REJECTION RATIO vs FREE-AIR TEMPERATURE

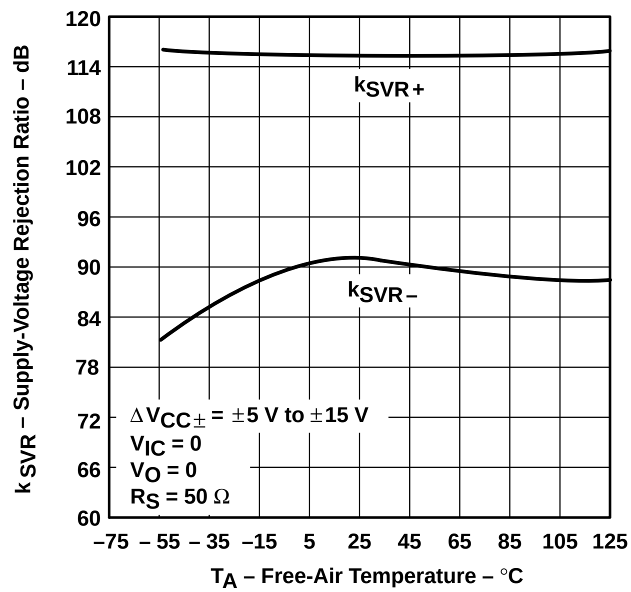


Figure 29

SUPPLY CURRENT vs SUPPLY VOLTAGE

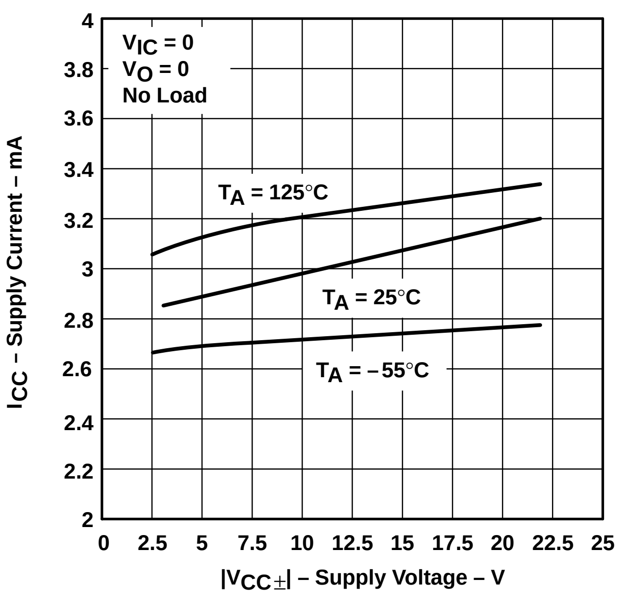


Figure 30

SUPPLY CURRENT vs FREE-AIR TEMPERATURE

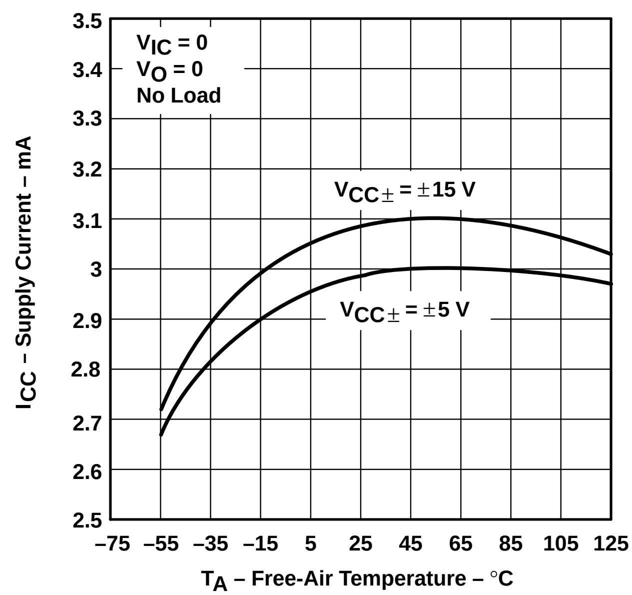


Figure 31

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

TYPICAL CHARACTERISTICS†

SUPPLY CURRENT
vs
DIFFERENTIAL INPUT VOLTAGE

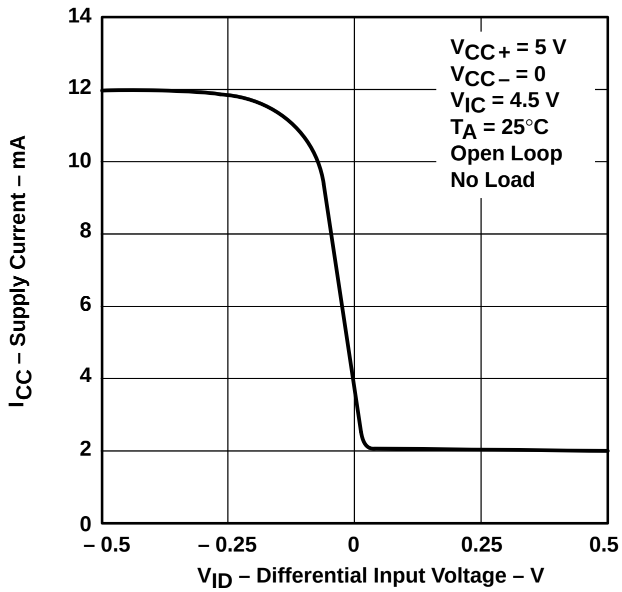


Figure 32

SUPPLY CURRENT
vs
DIFFERENTIAL INPUT VOLTAGE

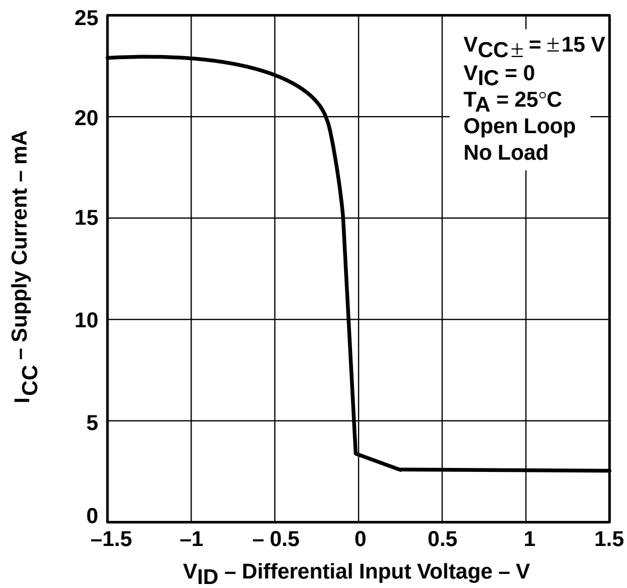


Figure 33

SHORT-CIRCUIT OUTPUT CURRENT
vs
SUPPLY VOLTAGE

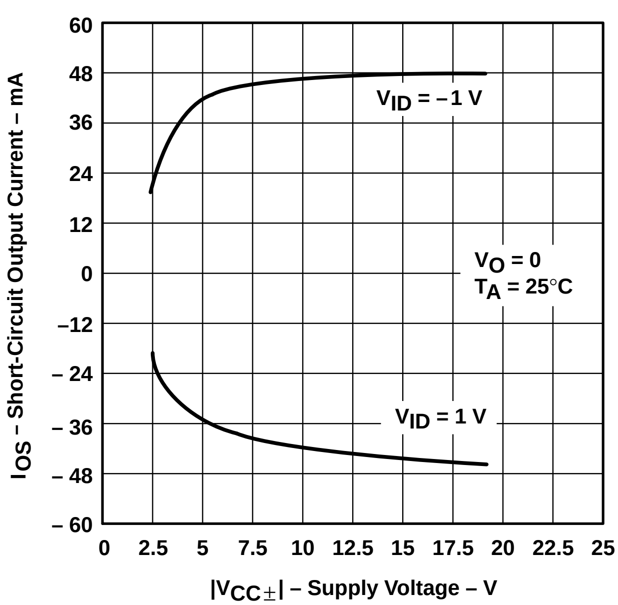


Figure 34

SHORT-CIRCUIT OUTPUT CURRENT
vs
ELAPSED TIME

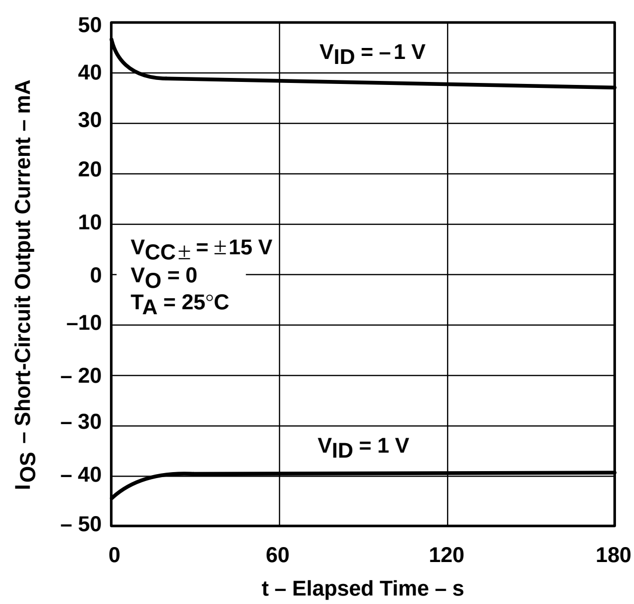


Figure 35

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

TYPICAL CHARACTERISTICS†

SHORT-CIRCUIT OUTPUT CURRENT vs FREE-AIR TEMPERATURE

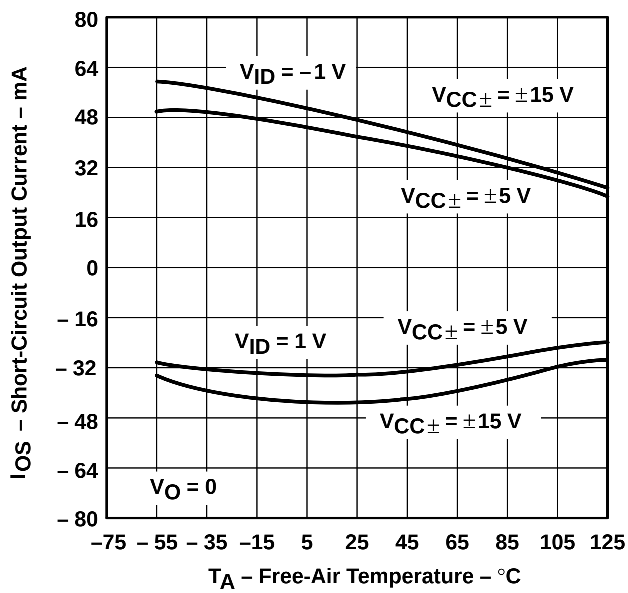


Figure 36

SLEW RATE vs FREE-AIR TEMPERATURE

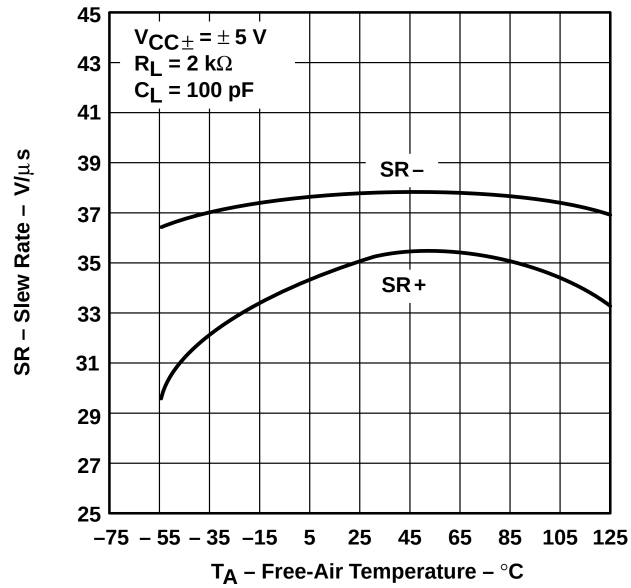


Figure 37

SLEW RATE vs FREE-AIR TEMPERATURE

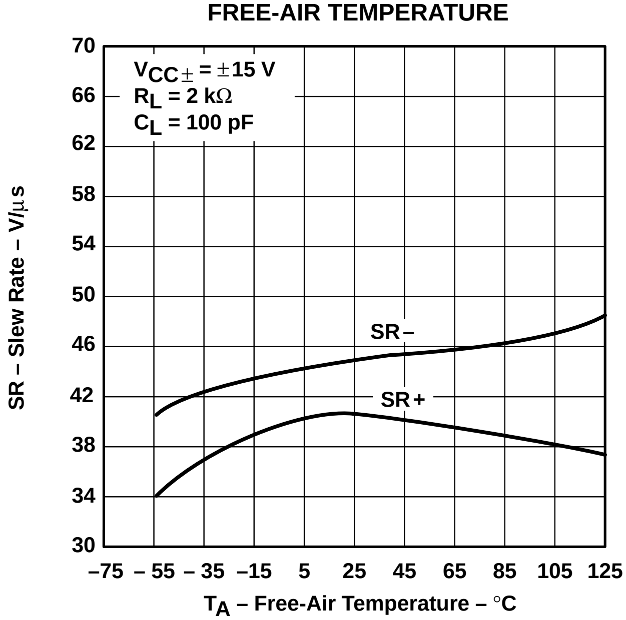


Figure 38

SLEW RATE vs LOAD RESISTANCE

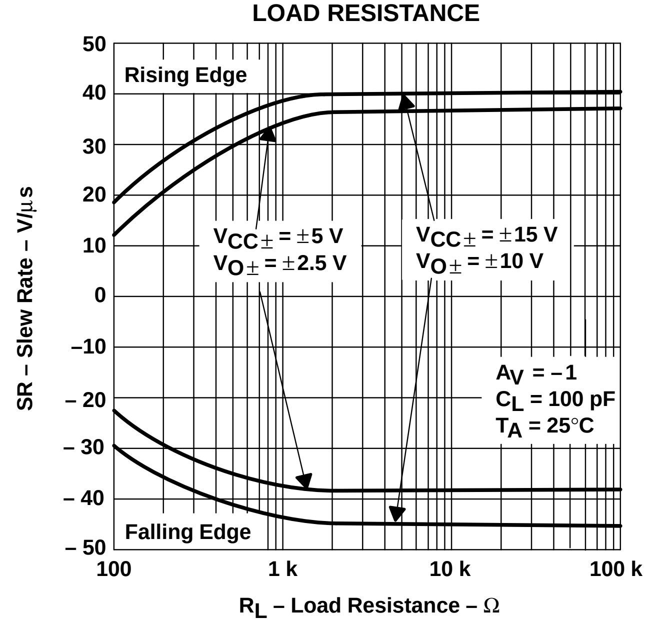


Figure 39

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

TYPICAL CHARACTERISTICS†

SLEW RATE vs DIFFERENTIAL INPUT VOLTAGE

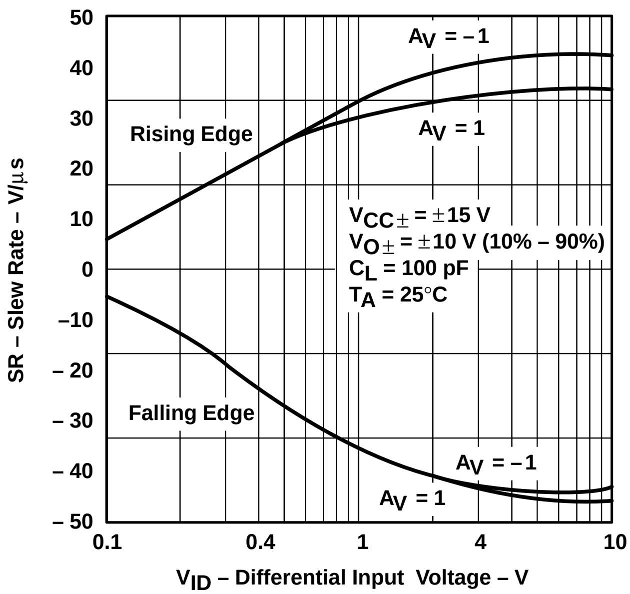


Figure 40

INPUT-REFERRED NOISE VOLTAGE SPECTRAL DENSITY vs FREQUENCY

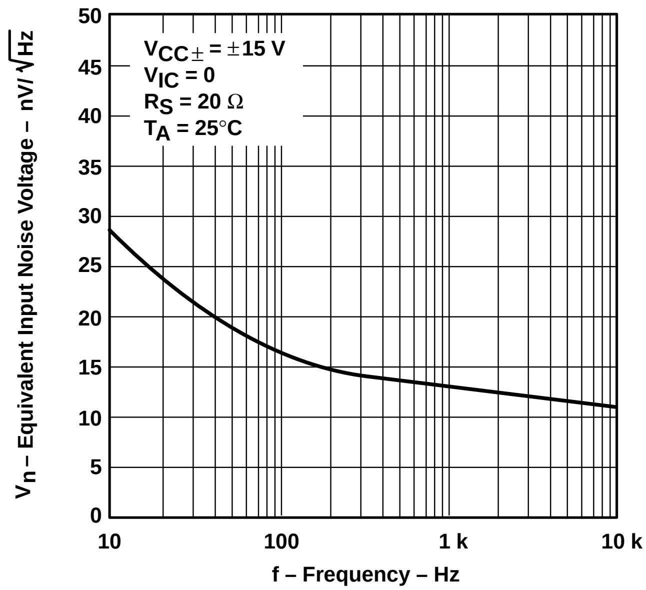


Figure 41

INPUT-REFERRED NOISE VOLTAGE vs NOISE BANDWIDTH

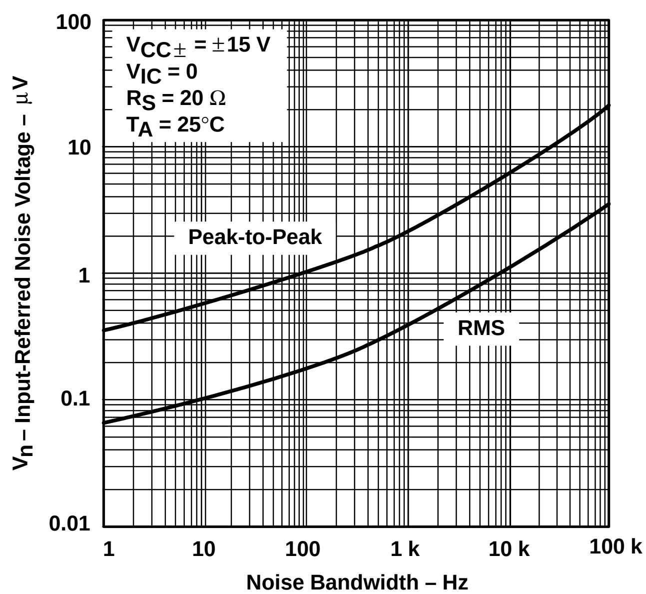


Figure 42

INPUT-REFERRED NOISE VOLTAGE OVER A 10-SECOND TIME INTERVAL

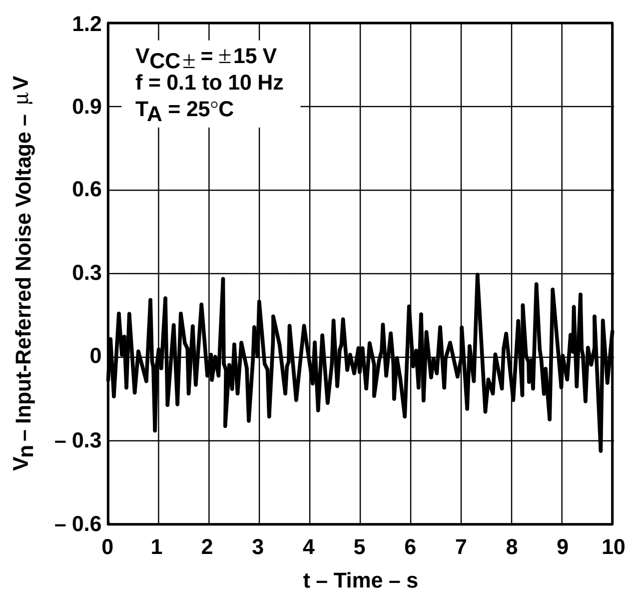


Figure 43

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

TYPICAL CHARACTERISTICS

**THIRD-OCTAVE SPECTRAL NOISE DENSITY
vs
FREQUENCY BANDS**

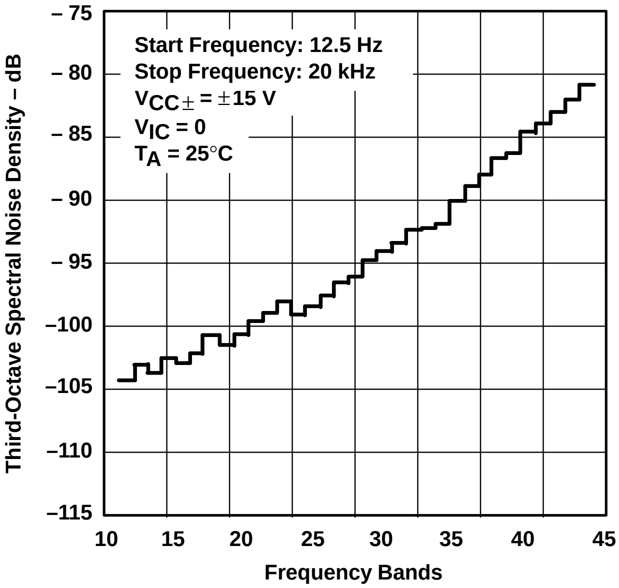


Figure 44

**TOTAL HARMONIC DISTORTION PLUS NOISE
vs
FREQUENCY**

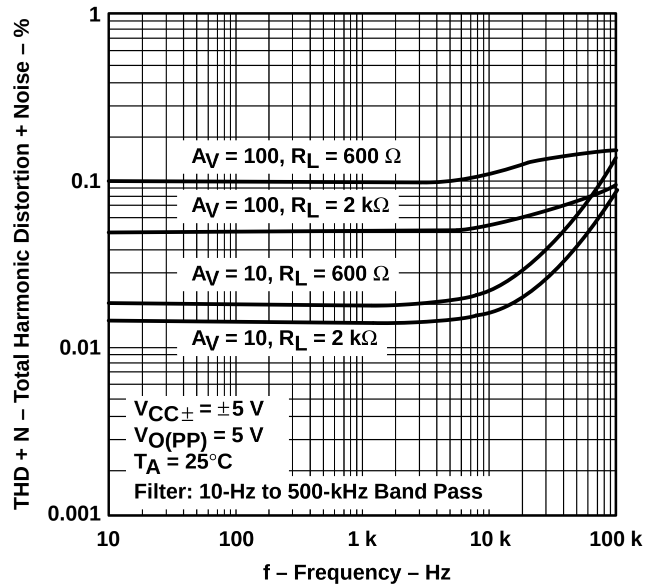


Figure 45

**TOTAL HARMONIC DISTORTION PLUS NOISE
vs
FREQUENCY**

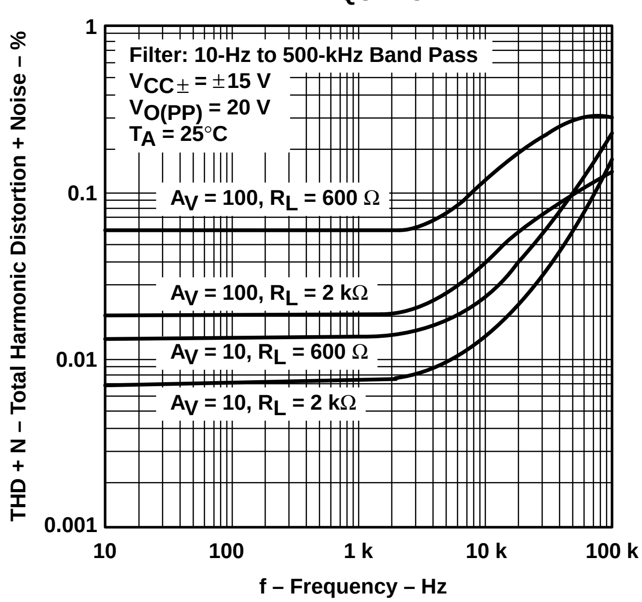


Figure 46

**UNITY-GAIN BANDWIDTH
vs
LOAD CAPACITANCE**

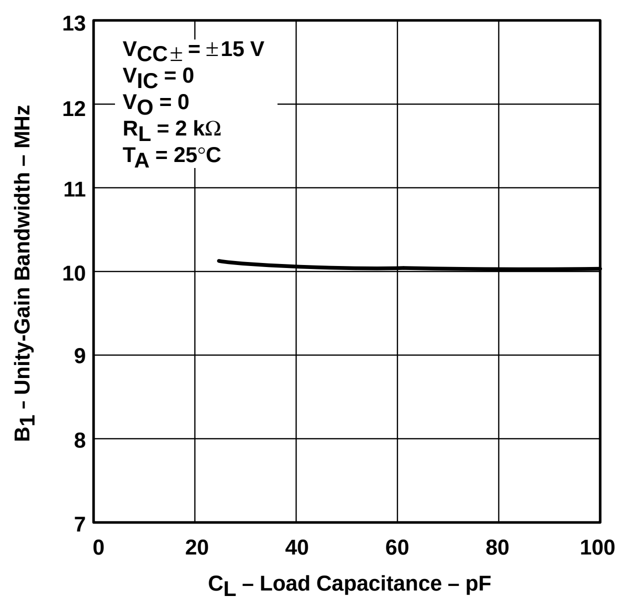


Figure 47

TYPICAL CHARACTERISTICS†

GAIN-BANDWIDTH PRODUCT vs FREE-AIR TEMPERATURE

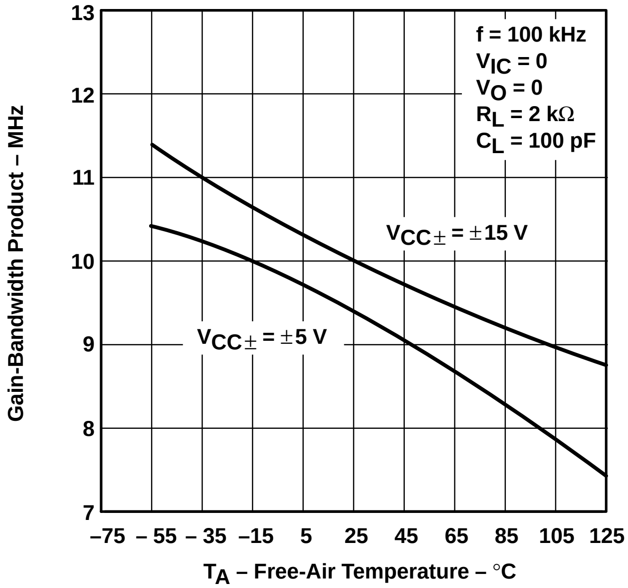


Figure 48

GAIN-BANDWIDTH PRODUCT vs SUPPLY VOLTAGE

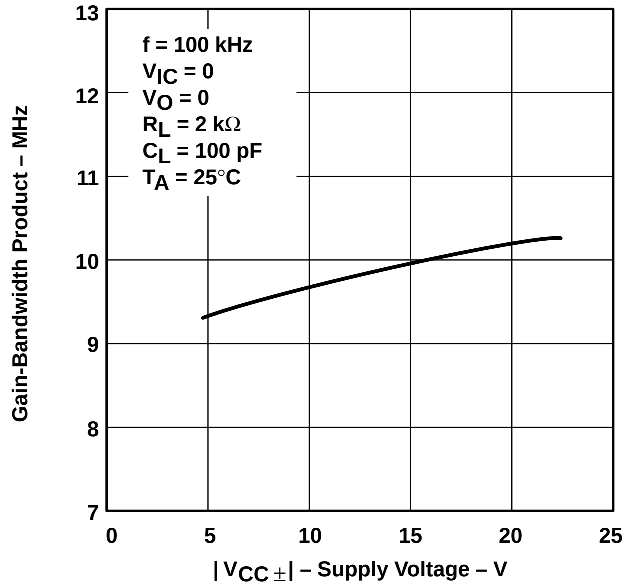


Figure 49

GAIN MARGIN vs LOAD CAPACITANCE

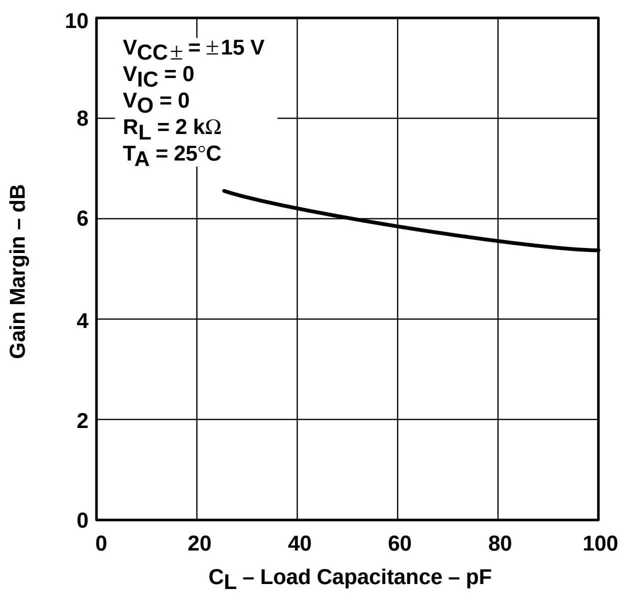


Figure 50

PHASE MARGIN vs FREE-AIR TEMPERATURE

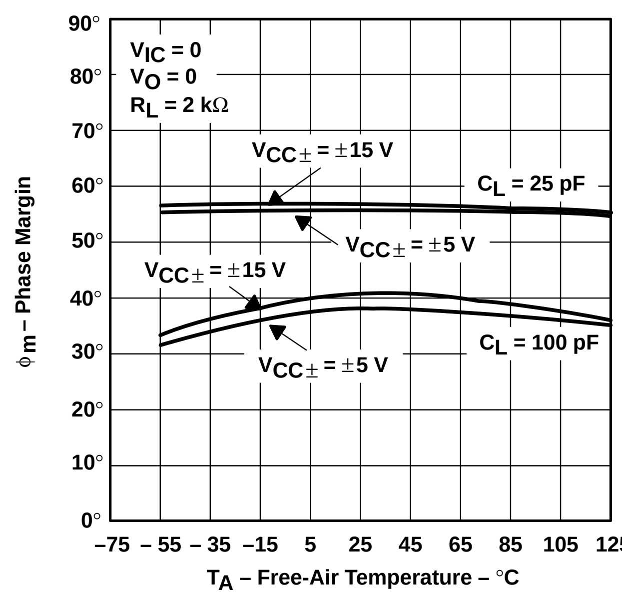


Figure 51

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

TYPICAL CHARACTERISTICS†

PHASE MARGIN vs SUPPLY VOLTAGE

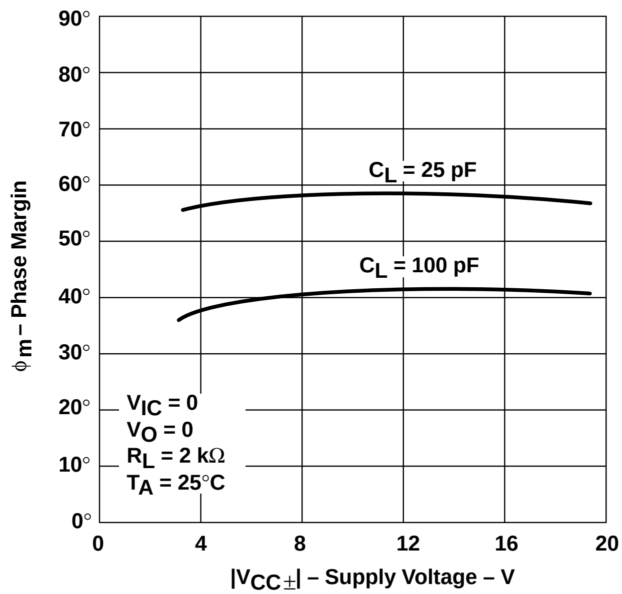


Figure 52

PHASE MARGIN vs LOAD CAPACITANCE

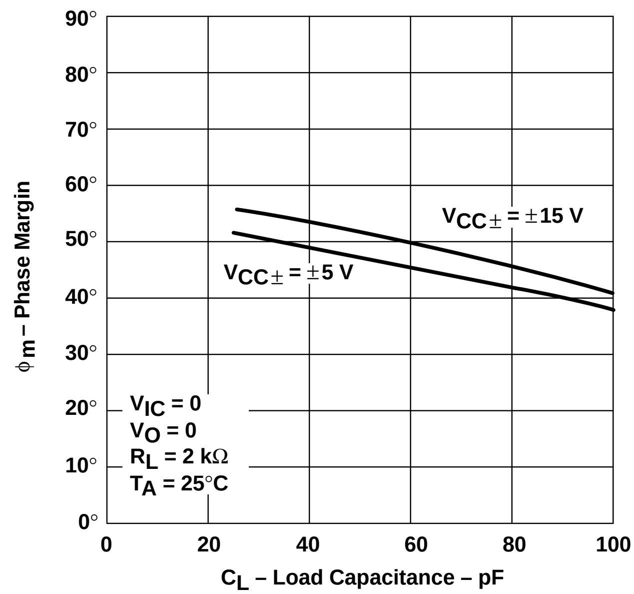


Figure 53

NONINVERTING LARGE-SIGNAL PULSE RESPONSE

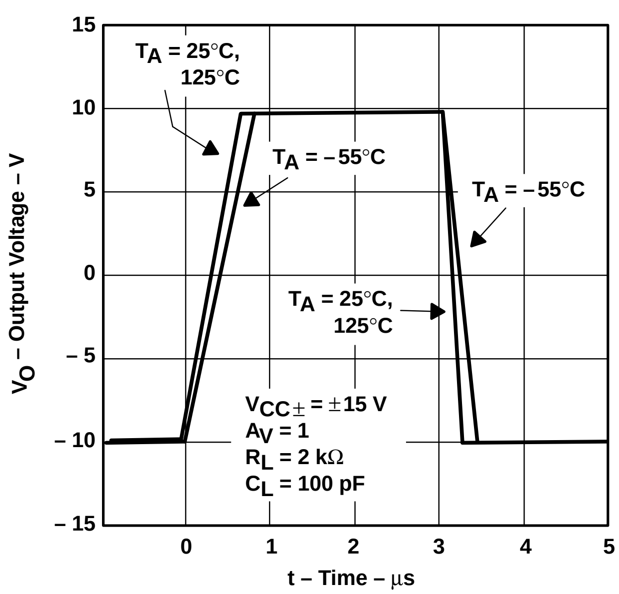


Figure 54

SMALL-SIGNAL PULSE RESPONSE

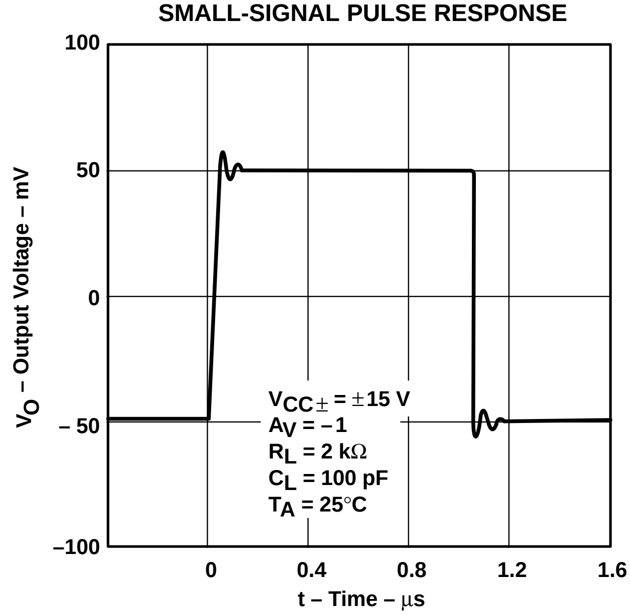


Figure 55

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

TYPICAL CHARACTERISTICS†

CLOSED-LOOP OUTPUT IMPEDANCE vs FREQUENCY

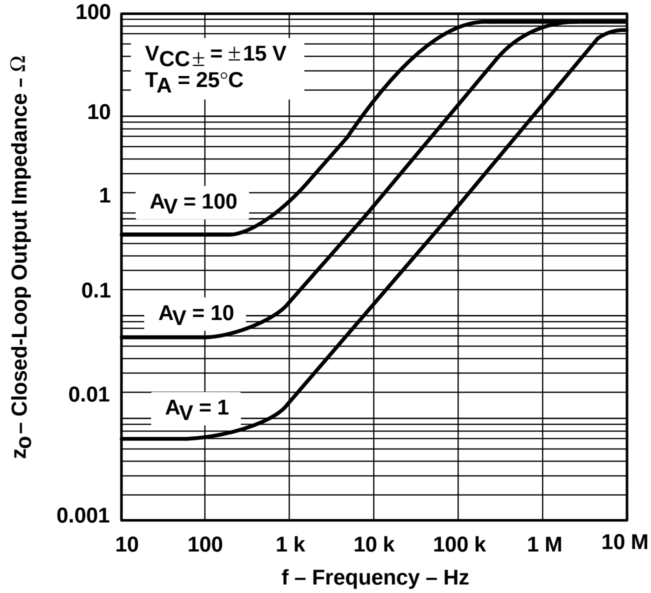


Figure 56

CROSSTALK ATTENUATION vs FREQUENCY

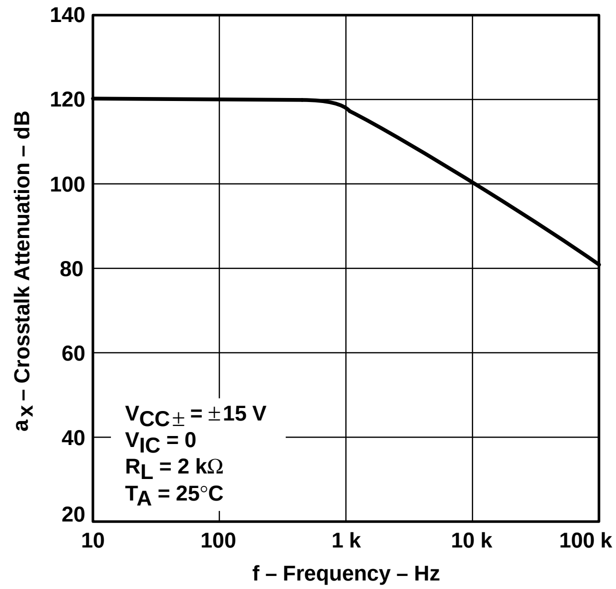


Figure 57

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

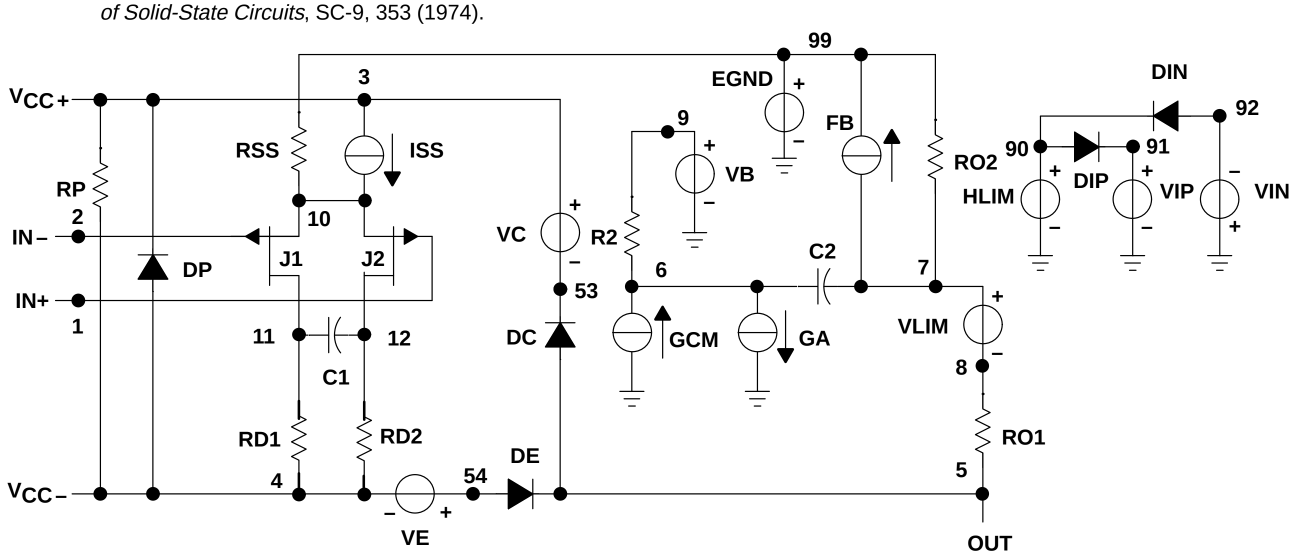
APPLICATION INFORMATION

macromodel information

Macromodel information provided was derived using *PSpice*™ *Parts*™ model generation software. The Boyle macromodel (see Note 4) and subcircuit in Figure 58 were generated using the TLE2072 typical electrical and operating characteristics at $T_A = 25°C$. 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 4: 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).




```
.SUBCKT TLE2072 1 2 3 4 5
        C1      11      12      2.2E–12
        C2      6       7       10.00E–12
        DC      5       53      DX
        DE      54      5       DX
        DLP     90      91      DX
        DLN     92      90      DX
        DP      4       3       DX
        EGND    99      0       POLY (2) (3,0) (4,0) 0 .5 .5
        FB      7       99      POLY (5) VB VC VE VLP
+ VLN 0 5.607E6 –6E6 6E6 6E6 –6E6
        GA      6       0       11 12 333.0E–6
        GCM     0       6       10 99 7.43E–9
        ISS     3       10      DC 400.0E–6
        HLIM    90      0       VLIM 1K
        J1      11      2       10 JX
        J2      12      1       10 JX
        R2      6       9       100.0E3
        RD1     4       11      3.003E3
        RD2     4       12      3.003E3
        R01     8       5       80
        R02     7       99      80
        RP      3       4       27.30E3
        RSS     10      99      500.0E3
        VB      9       0       DC 0
        VC      3       53      DC 2.20
        VE      54      4       DC 2.20
        VLIM    7       8       DC 0
        VLP     91      0       DC 45
        VLN     0       92      DC 45
.MODEL DX D (IS=800.0E–18)
.MODEL JX PJF (IS=15.00E–12 BETA=554.5E–6
+  VTO=–.6)
.ENDS
```

Figure 58. Boyle Macromodel and Subcircuit

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