- **Qualified for Automotive Applications**
- **Direct Upgrades to TL05x, TL07x, and TL08x BiFET Operational Amplifiers**
- **Greater Than 2× Bandwidth (10 MHz) and 3× Slew Rate (45 V/μs) Than TL07x**
- **Ensured Maximum Noise Floor 17 nV/√Hz**
- **On-Chip Offset Voltage Trimming for Improved DC Performance**
- **Wider Supply Rails Increase Dynamic Signal Range to ±19 V**

description/ordering information

The TLE207x series of JFET-input operational amplifiers more than double the bandwidth and triple the slew rate of the TL07x and TL08x families of BiFET operational amplifiers. Texas Instruments Excalibur process yields a typical noise floor of 11.6 nV/√Hz, 17-nV/√Hz ensured maximum, offering immediate improvement in noise-sensitive circuits designed using the TL07x. The TLE207x also has wider supply voltage rails, increasing the dynamic signal range for BiFET circuits to ±19 V. On-chip zener trimming of offset voltage yields precision grades for greater accuracy in dc-coupled applications. The TLE207x are pin-compatible with lower performance BiFET operational amplifiers for ease in improving performance in existing designs.

BiFET operational amplifiers offer the inherently higher input impedance of the JFET-input transistors, without sacrificing the output drive associated with bipolar amplifiers. This makes them better suited for interfacing with high-impedance sensors or very low-level ac signals. They also feature inherently better ac response than bipolar or CMOS devices having comparable power consumption.

The TLE207x family of BiFET amplifiers are Texas Instruments highest performance BiFETs, with tighter input offset voltage and ensured maximum noise specifications. Designers requiring less stringent specifications but seeking the improved ac characteristics of the TLE207x should consider the TLE208x operational amplifier family.

Because BiFET operational amplifiers are designed for use with dual power supplies, care must be taken to observe common-mode input voltage limits and output swing when operating from a single supply. DC biasing of the input signal is required and loads should be terminated to a virtual ground node at mid-supply. Texas Instruments TLE2426 integrated virtual ground generator is useful when operating BiFET amplifiers from single supplies.

ORDERING INFORMATION†

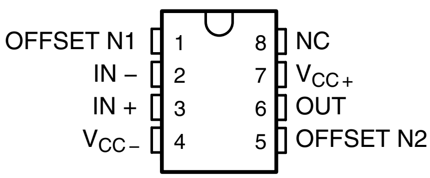
T_A	V_{IO}max AT 25°C	PACKAGE‡		ORDERABLE PART NUMBER	TOP-SIDE MARKING
−40°C to 125°C	2 mV	SOIC – D	Tape and reel	TLE2071AQDRQ1	2071AQ
	4 mV	SOIC – D	Tape and reel	TLE2071QDRQ1	2071Q1
	3.5 mV	SOIC – D	Tape and reel	TLE2072AQDRQ1	2072AQ
	6 mV	SOIC – D	Tape and reel	TLE2072QDRQ1	2072Q1
	4 mV	SOP – DW	Tape and reel	TLE2074AQDWRQ1§	TLE2074AQ1
	7 mV	SOP – DW	Tape and reel	TLE2074QDWRQ1§	TLE2074Q1

† For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at http://www.ti.com.
‡ Package drawings, thermal data, and symbolization are available at http://www.ti.com/packaging.
§ Product Preview

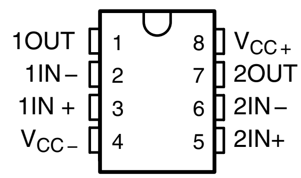
description/ordering information (continued)

The TLE207x are fully specified at ±15 V and ±5 V. For operation in low-voltage and/or single-supply systems, Texas Instruments LinCMOS families of operational amplifiers (TLC- and TLV-prefix) are recommended. When moving from BiFET to CMOS amplifiers, particular attention should be paid to slew rate and bandwidth requirements and output loading.

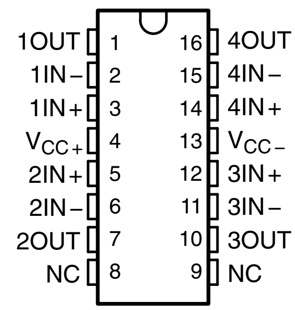
TLE2071 AND TLE2071A
D PACKAGE
(TOP VIEW)



TLE2072 AND TLE2072A
D PACKAGE
(TOP VIEW)

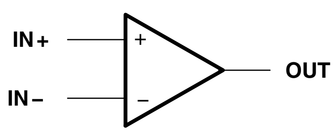


TLE2074 AND TLE2074A
DW PACKAGE
(TOP VIEW)

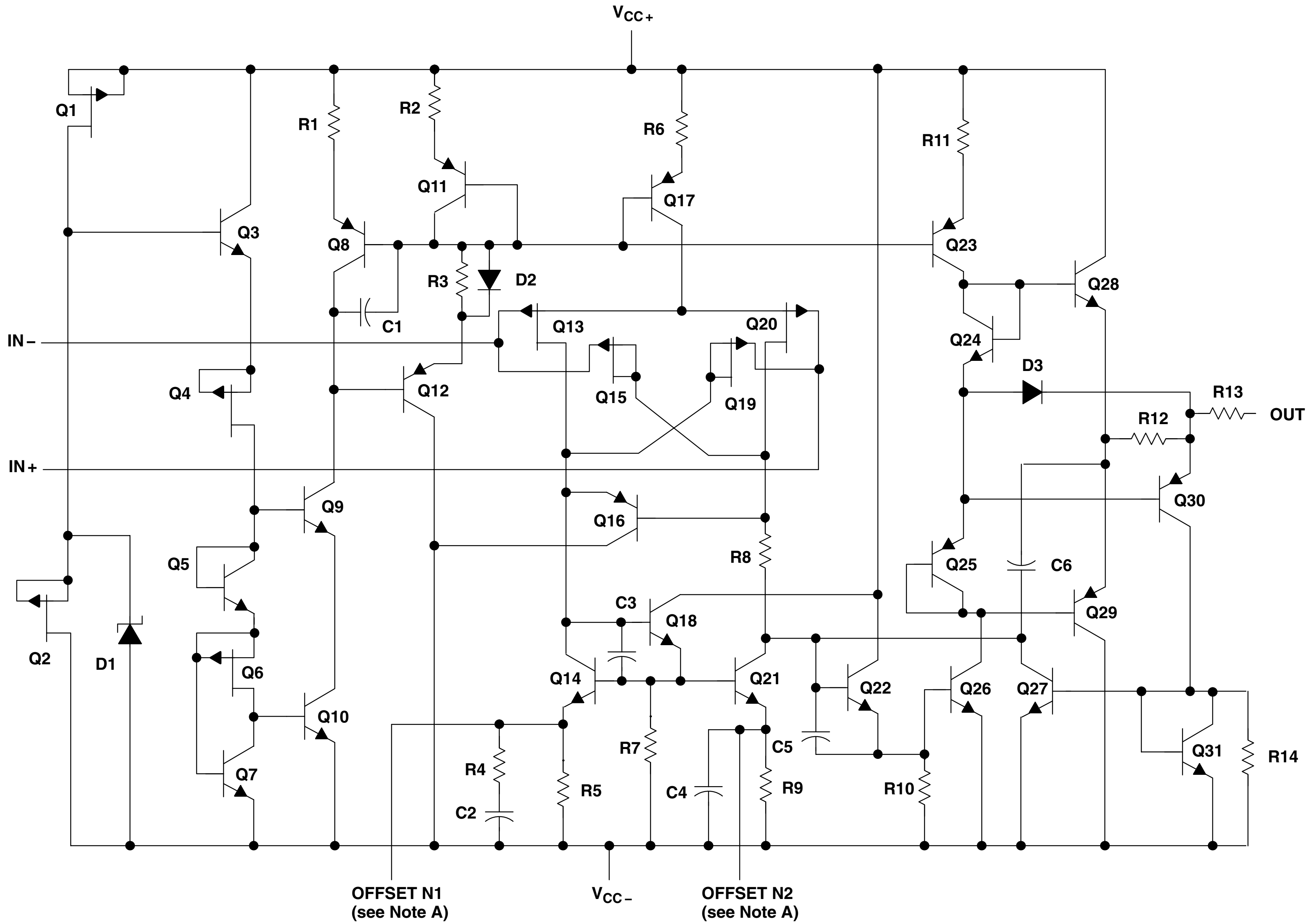


NC – No internal connection

symbol



equivalent schematic



NOTES: A. OFFSET N1 AND OFFSET N2 are only availiable on the TLE2071x devices.

equivalent schematic (continued)

ACTUAL DEVICE COMPONENT COUNT			
COMPONENT	**TLE2071**	**TLE2072**	**TLE2074**
Transistors	33	57	114
Resistors	25	37	74
Diodes	8	5	10
Capacitors	6	11	22

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
Maximum Junction Temperature, T_J .... 150°C
Package thermal impedance, θ_{JA} (see Note 4): D package .... 126°C/W
DW package .... 75°C/W
Operating free-air temperature range, T_A: Q suffix .... –40°C to 125°C
Storage temperature range .... –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 3 seconds .... 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 the noninverting input with respect to the inverting input.
3. The output may be shorted to either supply. Temperatures and/or supply voltages must be limited to ensure that the maximum dissipation rate is not exceeded.
4. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions

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

TLE2071-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm}$ = ±5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2071-Q1 MIN	TLE2071-Q1 TYP	TLE2071-Q1 MAX	TLE2071A-Q1 MIN	TLE2071A-Q1 TYP	TLE2071A-Q1 MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0, V_O = 0, R_S = 50 Ω,		25°C		0.34	4		0.3	2	mV
				Full range			9			7	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		3.2			3.2	20	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			60			60	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			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}$ /ΔV_{IO})	$V_{CC\pm}$ = ±5 V to ±15 V, V_O = 0, R_S = 50 Ω		25°C	82	99		82	99		dB
				Full range	80			80			

† Full range is –40°C to 125°C.

TLE2071-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLE2071-Q1 MIN	TLE2071-Q1 TYP	TLE2071-Q1 MAX	TLE2071A-Q1 MIN	TLE2071A-Q1 TYP	TLE2071A-Q1 MAX	UNIT
I_{CC}	Supply current	$V_O = 0$,	No load	25°C	1.35	1.6	2.2	1.35	1.6	2.2	mA
				Full range			2.2			2.2	
I_{OS}	Short-circuit output current	$V_O = 0$	$V_{ID} = 1$ V	25°C		–35			–35		mA
			$V_{ID} = -1$ V			45			45		

† Full range is –40°C to 125°C.

TLE2071-Q1 operating characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V

PARAMETER		TEST CONDITIONS		T_A†	TLE2071-Q1 MIN	TLE2071-Q1 TYP	TLE2071-Q1 MAX	TLE2071A-Q1 MIN	TLE2071A-Q1 TYP	TLE2071A-Q1 MAX	UNIT
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 125°C.

TLE2071-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm 15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2071-Q1			TLE2071A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$		25°C		0.49	4		0.47	2	mV
				Full range			9			7	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		3.2			3.2	20	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			60			60	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	13.3			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	$V_O = \pm 10$ V	$R_L = 600\ \Omega$	25°C	80	96		80	96		dB
				Full range	78			78			
			$R_L = 2$ kΩ	25°C	90	109		90	109		
				Full range	88			88			
			$R_L = 10$ kΩ	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 ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm 5$ V to ± 15 V, $V_O = 0$, $R_S = 50\ \Omega$		25°C	82	99		82	99		dB
				Full range	80			80			

† Full range is –40°C to 125°C.

TLE2071-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm}$ = ±15 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLE2071-Q1			TLE2071A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
I_{CC}	Supply current	V_O = 0,	No load	25°C	1.35	1.7	2.2	1.35	1.7	2.2	mA
				Full range			2.2			2.2	
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		

† Full range is –40°C to 125°C.

TLE2071-Q1 operating characteristics at specified free-air temperature, $V_{CC\pm}$ = ±15 V

PARAMETER		TEST CONDITIONS		T_A†	TLE2071-Q1			TLE2071A-Q1			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	30	40		30	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 = 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 –40°C to 125°C.

TLE2072-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm}$ = ±5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072-Q1 MIN	TLE2072-Q1 TYP	TLE2072-Q1 MAX	TLE2072A-Q1 MIN	TLE2072A-Q1 TYP	TLE2072A-Q1 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			8	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		2.3			2.3	20	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			60			60	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			

† Full range is –40°C to 125°C.

TLE2072-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072-Q1 MIN	TLE2072-Q1 TYP	TLE2072-Q1 MAX	TLE2072A-Q1 MIN	TLE2072A-Q1 TYP	TLE2072A-Q1 MAX	UNIT
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		

† Full range is –40°C to 125°C.

TLE2072-Q1 operating characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V

PARAMETER		TEST CONDITIONS		T_A†	TLE2072-Q1 MIN	TLE2072-Q1 TYP	TLE2072-Q1 MAX	TLE2072A-Q1 MIN	TLE2072A-Q1 TYP	TLE2072A-Q1 MAX	UNIT
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/√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, $R_S = 25\ \Omega$	$A_{VD} = 10$, $R_L = 2\ k\Omega$,	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		

† Full range is –40°C to 125°C.

TLE2072-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072-Q1 MIN	TLE2072-Q1 TYP	TLE2072-Q1 MAX	TLE2072A-Q1 MIN	TLE2072A-Q1 TYP	TLE2072A-Q1 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			8	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		2.4			2.4	20	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			60			60	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	$V_O = \pm 10$ 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			

† Full range is −40°C to 125°C.

TLE2072-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm}$ = ±15 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLE2072-Q1			TLE2072A-Q1			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		

† Full range is –40°C to 125°C.

TLE2072-Q1 operating characteristics at specified free-air temperature, $V_{CC\pm}$ = ±15 V

PARAMETER		TEST CONDITIONS		T_A†	TLE2072-Q1			TLE2072A-Q1			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		

† Full range is –40°C to 125°C.

TLE2074-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2074-Q1 MIN	TLE2074-Q1 TYP	TLE2074-Q1 MAX	TLE2074A-Q1 MIN	TLE2074A-Q1 TYP	TLE2074A-Q1 MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0, V_O = 0, R_S = 50Ω		25°C		–1.6	7		–0.5	4	mV
				Full range			11			9	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		10.1			10.1	30	µV/°C
I_{IO}	Input offset current	V_{IC} = 0, V_O = 0, See Figure 4		25°C		15	100		15	100	pA
				Full range			20			20	nA
I_{IB}	Input bias current			25°C		20	175		20	175	pA
				Full range			60			60	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 — Common mode	V_{IC} = 0, See Figure 5		25°C		11			11		pF
	Input capacitance — 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			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm} / \Delta V_{IO}$)	$V_{CC\pm}$ = ±5 V to ±15 V, V_O = 0, R_S = 50 Ω		25°C	82	99		82	99		dB
				Full range	80			80			

† Full range is –40°C to 125°C.

TLE2074-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLE2074-Q1			TLE2074A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
I_{CC}	Supply current (four amplifiers)	$V_O = 0$,	No load	25°C	5.2	6.3	7.5	5.2	6.3	7.5	mA
				Full range			7.5			7.5	
	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		

† Full range is –40°C to 125°C.

TLE2074-Q1 operating characteristics at specified free-air temperature, $V_{CC\pm} = \pm5$ V

PARAMETER		TEST CONDITIONS		T_A†	TLE2074-Q1			TLE2074A-Q1			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/√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, $R_S = 25\ \Omega$	$A_{VD} = 10$, $R_L = 2\ k\Omega$,	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
f_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		

† Full range is –40°C to 125°C.

TLE2074-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm}$ = ±15 V (unless otherwise noted)

PARAMETER			TEST CONDITIONS		T_A†	TLE2074-Q1			TLE2074A-Q1			UNIT
						MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage		V_{IC} = 0, V_O = 0, R_S = 50 Ω		25°C		–1.6	7		–0.5	4	mV
					Full range			11			9	
α_{VIO}	Temperature coefficient of input offset voltage				Full range		10.1			10.1	30	µV/°C
I_{IO}	Input offset current		V_{IC} = 0, V_O = 0, See Figure 4		25°C		15	100		15	100	pA
					Full range			20			20	nA
I_{IB}	Input bias current				25°C		25	175		25	175	pA
					Full range			60			60	nA
V_{ICR}	Common-mode input voltage range		R_S = 50 Ω		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 µA		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 µA		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 = ±10 V	R_L = 600 Ω	25°C	80	96		80	96		dB
					Full range	78			78			
				R_L = 2 kΩ	25°C	90	109		90	109		
					Full range	88			88			
				R_L = 10 kΩ	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	Common mode	V_{IC} = 0, See Figure 5		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 Ω		25°C	80	98		80	98		dB
					Full range	78			78			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)		$V_{CC\pm}$ = ±5 V to ±15 V, V_O = 0, R_S = 50 Ω		25°C	82	99		82	99		dB
					Full range	80			80			

† Full range is –40°C to 125°C.

TLE2074-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm15$ V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLE2074-Q1			TLE2074A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
I_{CC}	Supply current (four amplifiers)	$V_O = 0$,	No load	25°C	5.2	6.5	7.5	5.2	6.5	7.5	mA
				Full range			7.5			7.5	
	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	–30	–45		–30	–45		mA
			$V_{ID} = –1$ V		30	48		30	48		

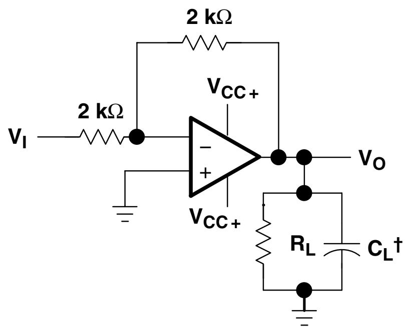
† Full range is –40°C to 125°C.

TLE2074-Q1 operating characteristics at specified free-air temperature, $V_{CC\pm} = \pm15$ V

PARAMETER		TEST CONDITIONS		T_A†	TLE2074-Q1			TLE2074A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	$V_{O(PP)} = 10$ V, $R_L = 2\ k\Omega$, See Figure 1	$A_{VD} = –1$, $C_L = 100$ pF,	25°C	25	40		25	40		V/µs
				Full range	17			17			
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, $R_L = 1\ k\Omega$, $C_L = 100$ pF	To 10 mV	25°C		0.4			0.4		µs
			To 1 mV			1.5			1.5		
V_n	Equivalent input noise voltage	$R_S = 20\ \Omega$, 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, $R_S = 25\ \Omega$	$A_{VD} = 10$, $R_L = 2\ k\Omega$,	25°C		0.008%			0.008%		
B_1	Unity-gain bandwidth	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2\ k\Omega$, See Figure 2	25°C	8	10		8	10		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 20$ V, $R_L = 2\ k\Omega$,	$A_{VD} = –1$, $C_L = 25$ pF	25°C	478	637		478	637		kHz
ϕ_m	Phase margin at unity gain	$V_I = 10$ mV, $C_L = 25$ pF,	$R_L = 2\ k\Omega$, See Figure 2	25°C		57			57		

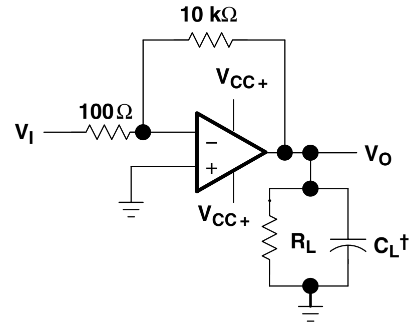
† Full range is –40°C to 125°C.

PARAMETER MEASUREMENT INFORMATION



† Includes fixture capacitance

Figure 1. Slew-Rate Test Circuit



† Includes fixture capacitance

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

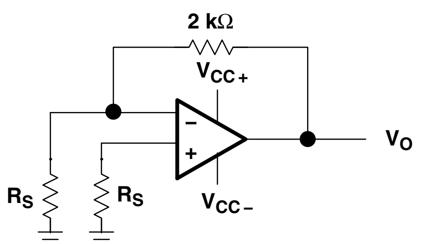


Figure 3. Noise-Voltage Test Circuit

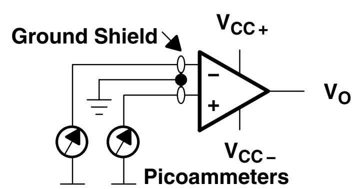


Figure 4. Input-Bias and Offset-Current Test Circuit

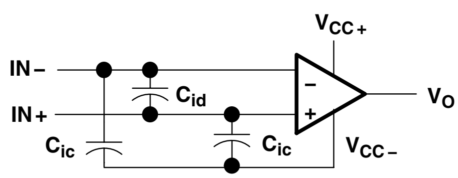


Figure 5. Internal Input Capacitance

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 TLE207x and TLE207xA, accurate measurement of the bias current 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

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TYPICAL CHARACTERISTICS

DISTRIBUTION OF TLE2071 INPUT OFFSET VOLTAGE

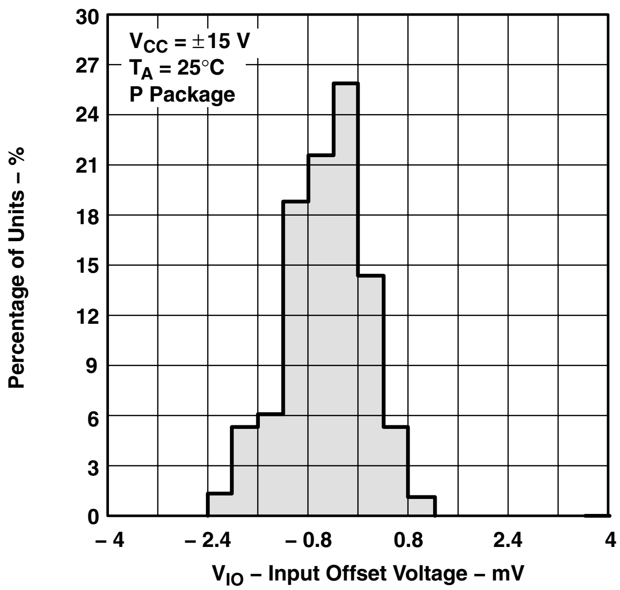


Figure 6

DISTRIBUTION OF TLE2072 INPUT OFFSET VOLTAGE

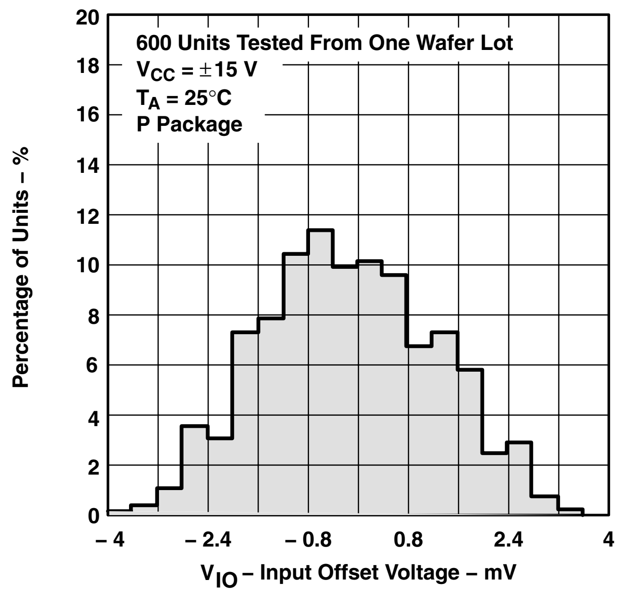


Figure 7

DISTRIBUTION OF TLE2074 INPUT OFFSET VOLTAGE

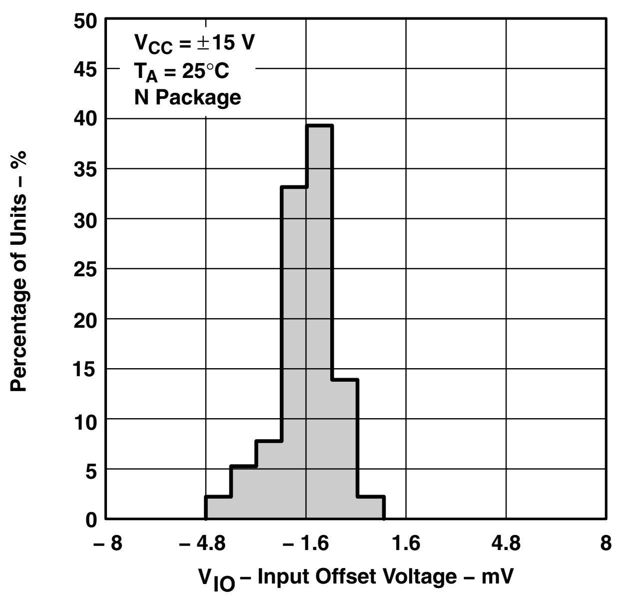


Figure 8

DISTRIBUTION OF TLE2071 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT

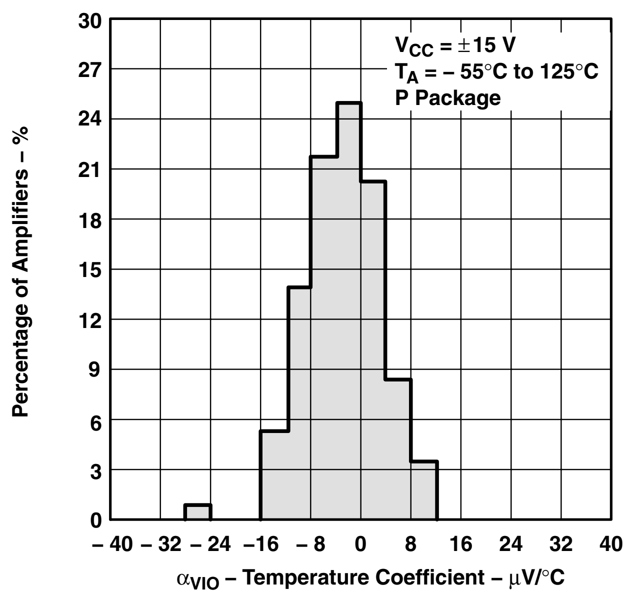


Figure 9

TYPICAL CHARACTERISTICS

DISTRIBUTION OF TLE2072 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT

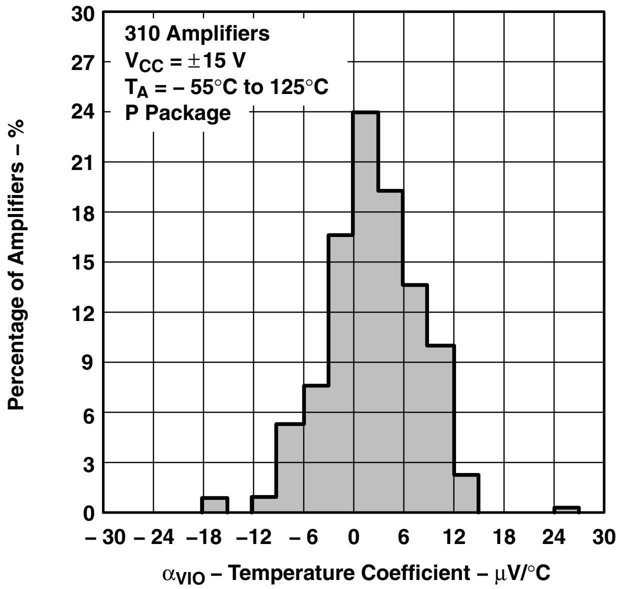


Figure 10

DISTRIBUTION OF TLE2074 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT

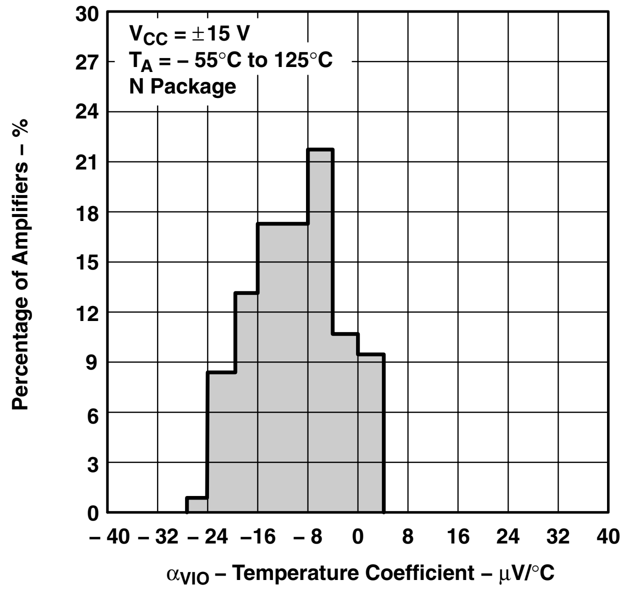


Figure 11

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

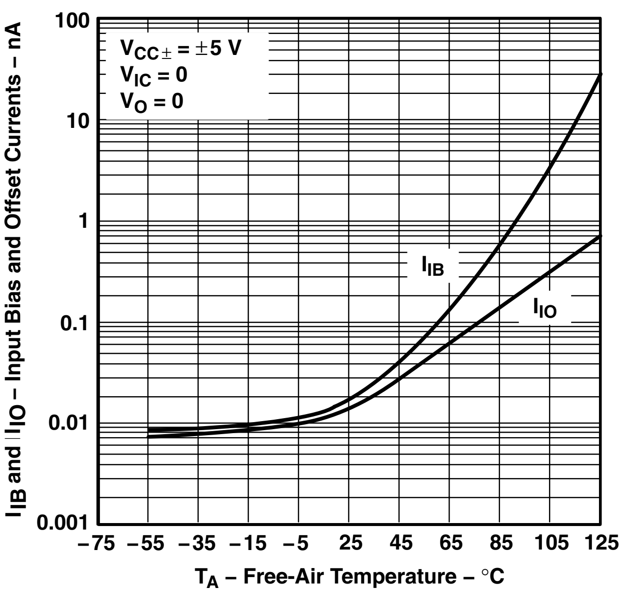


Figure 12

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

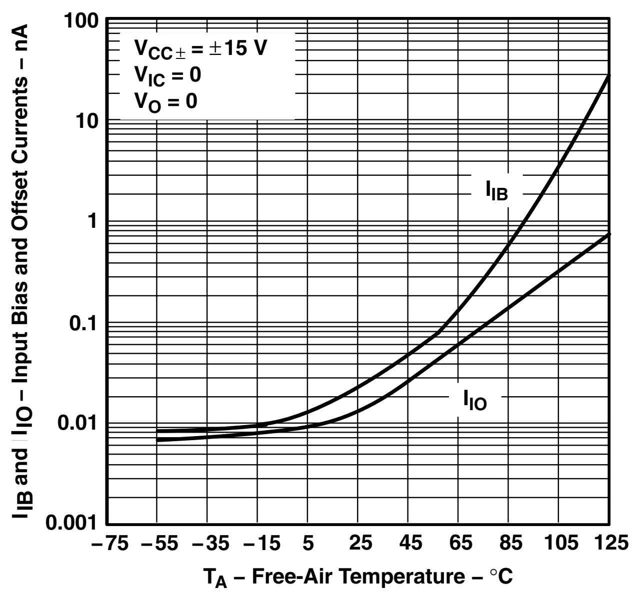


Figure 13

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

TYPICAL CHARACTERISTICS

INPUT BIAS CURRENT vs TOTAL SUPPLY VOLTAGE

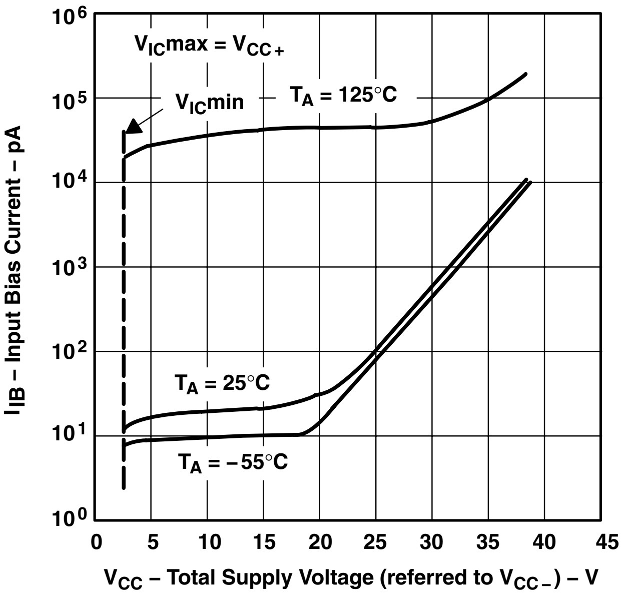


Figure 14

COMMON-MODE INPUT VOLTAGE RANGE† vs FREE-AIR TEMPERATURE

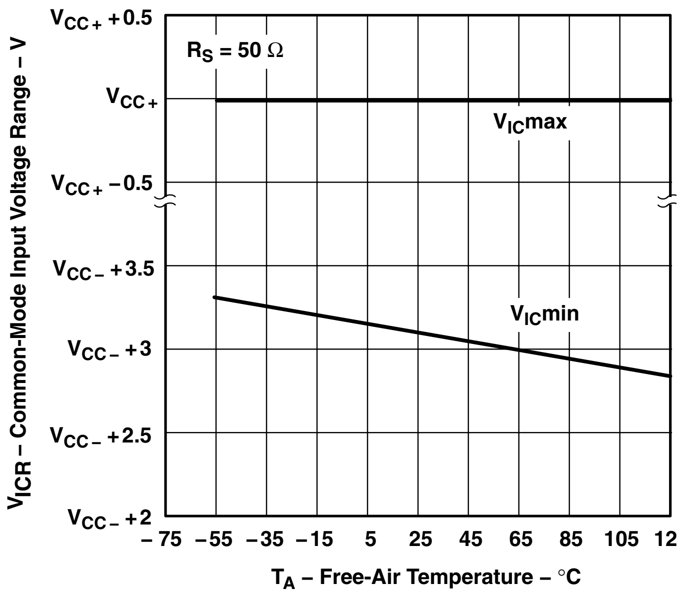


Figure 15

OUTPUT VOLTAGE vs DIFFERENTIAL INPUT VOLTAGE

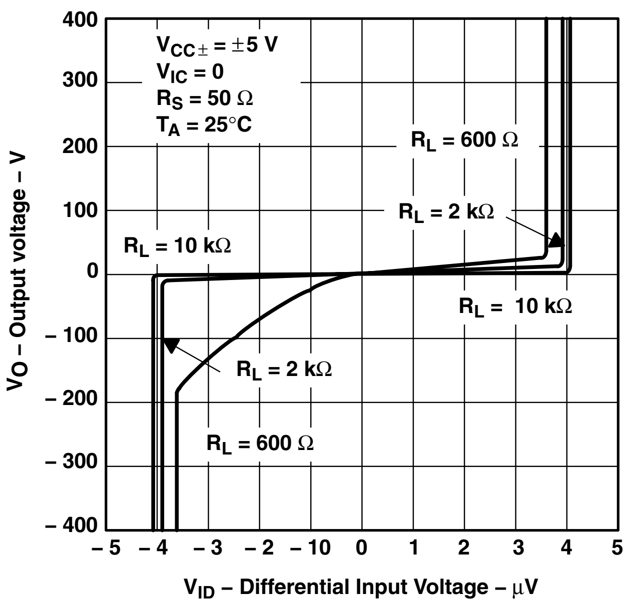


Figure 16

OUTPUT VOLTAGE vs DIFFERENTIAL INPUT VOLTAGE

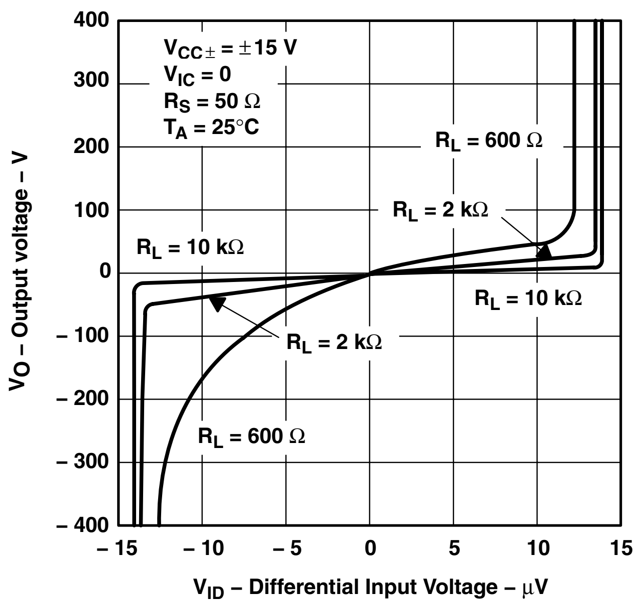


Figure 17

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

TYPICAL CHARACTERISTICS

**MAXIMUM POSITIVE PEAK OUTPUT VOLTAGE†
vs
OUTPUT CURRENT**

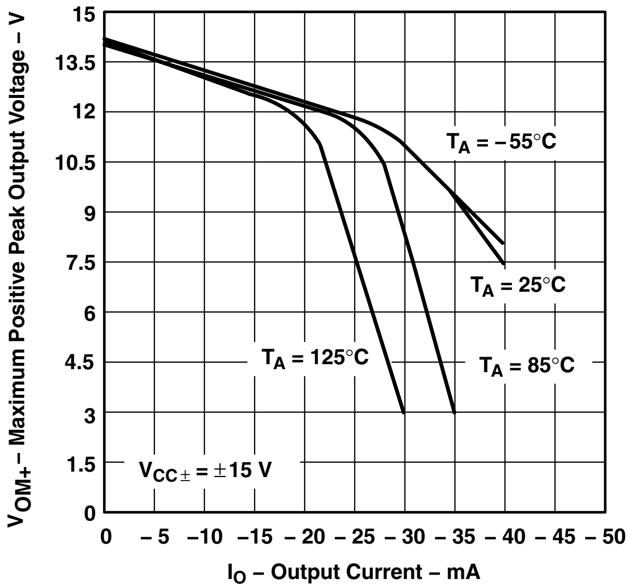


Figure 18

**MAXIMUM NEGATIVE PEAK OUTPUT VOLTAGE†
vs
OUTPUT CURRENT**

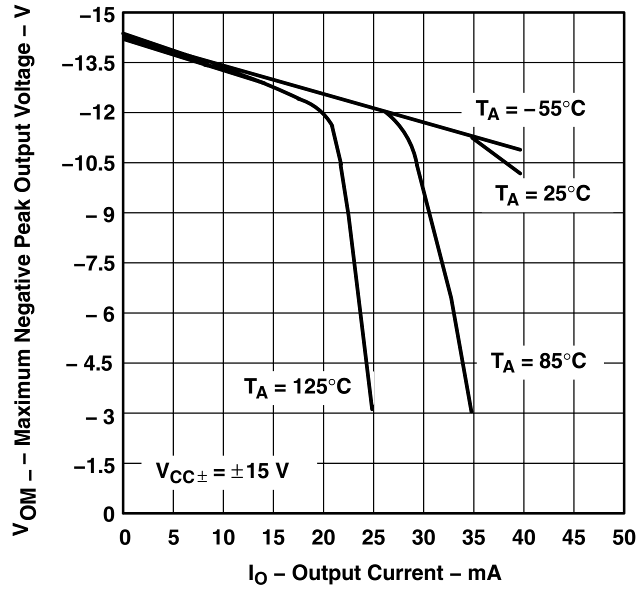


Figure 19

**MAXIMUM PEAK OUTPUT VOLTAGE†
vs
FREE-AIR TEMPERATURE**

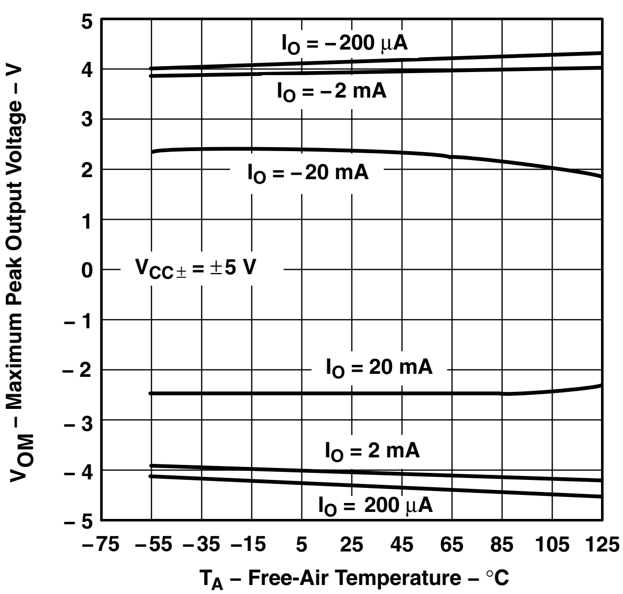


Figure 20

**MAXIMUM PEAK OUTPUT VOLTAGE†
vs
FREE-AIR TEMPERATURE**

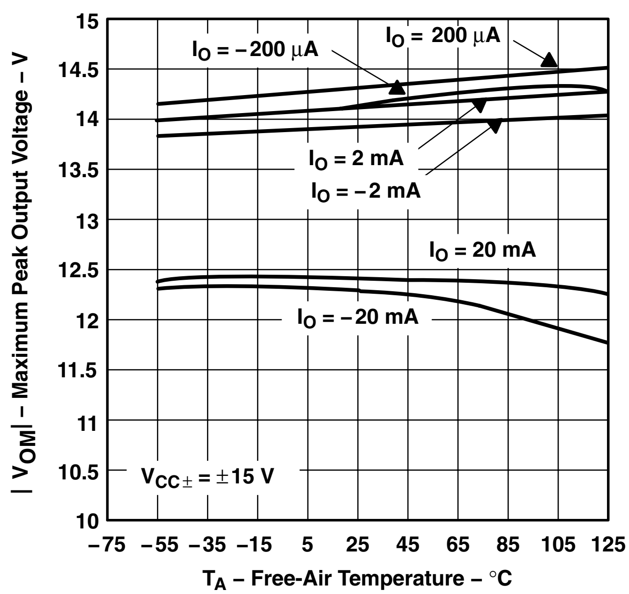


Figure 21

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

TYPICAL CHARACTERISTICS

MAXIMUM PEAK OUTPUT VOLTAGE
vs
SUPPLY VOLTAGE

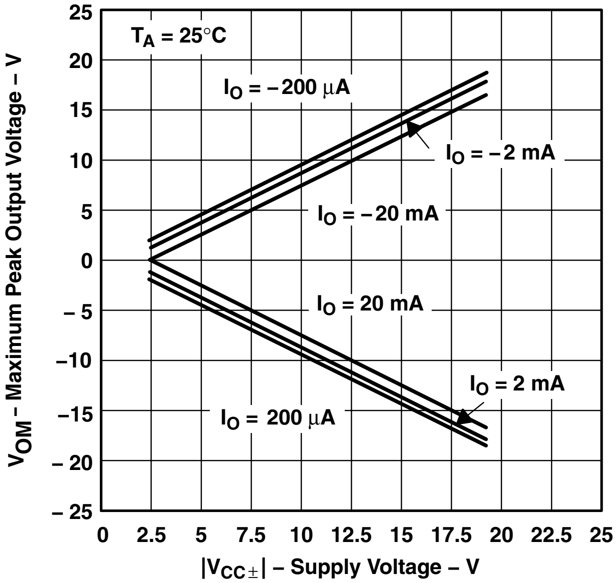


Figure 22

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE†
vs
FREQUENCY

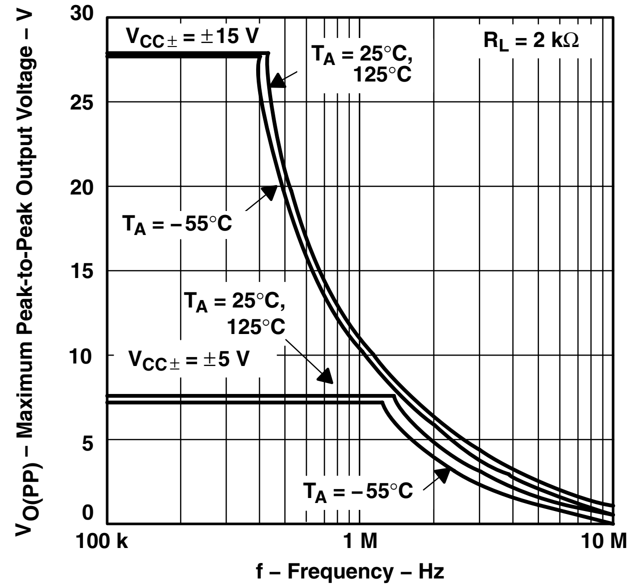


Figure 23

OUTPUT VOLTAGE
vs
SETTLING TIME

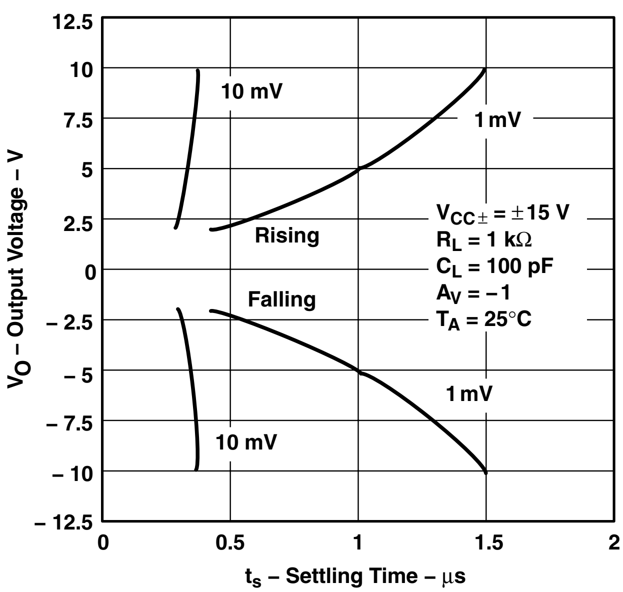


Figure 24

LARGE-SIGNAL DIFFERENTIAL
VOLTAGE AMPLIFICATION
vs
LOAD RESISTANCE

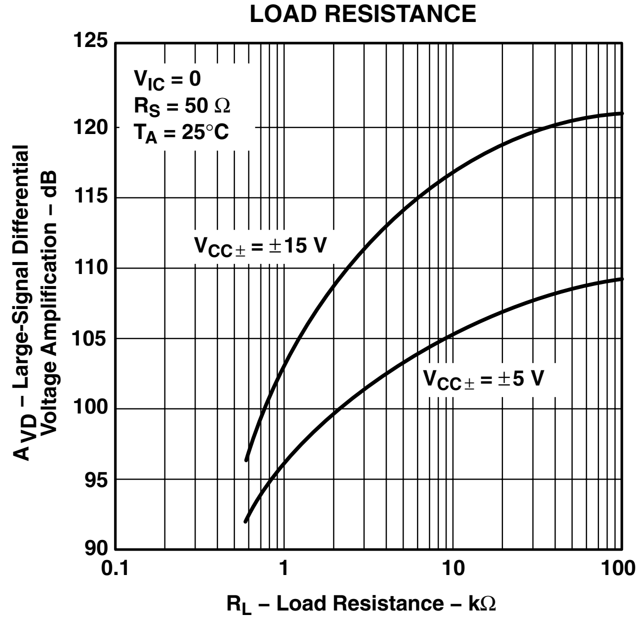


Figure 25

† 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

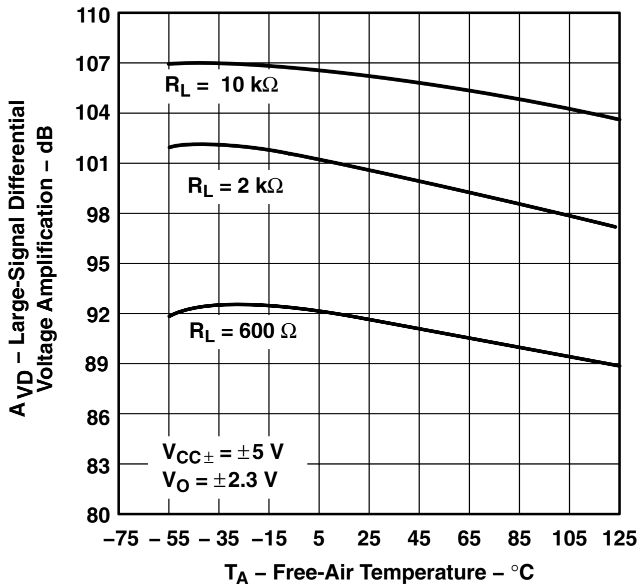


Figure 26

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

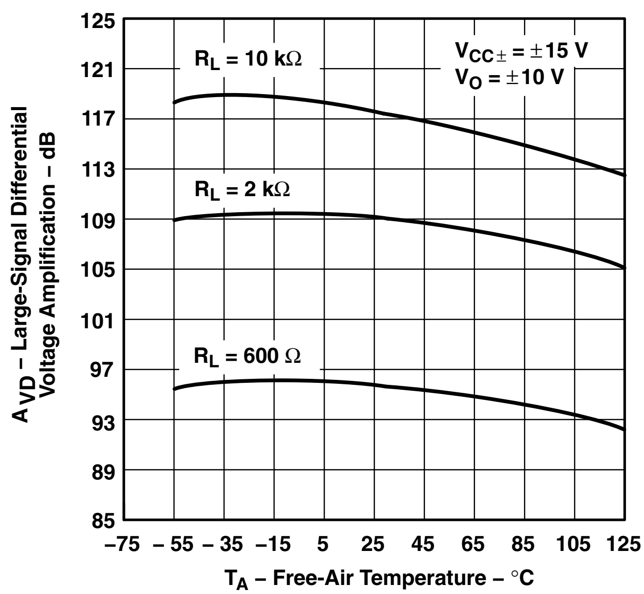


Figure 27

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

TYPICAL CHARACTERISTICS

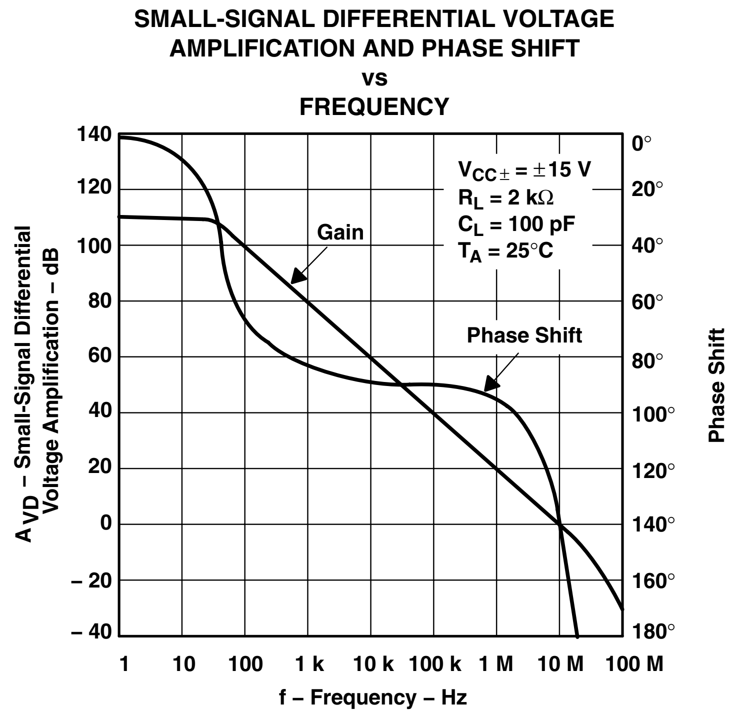


Figure 28

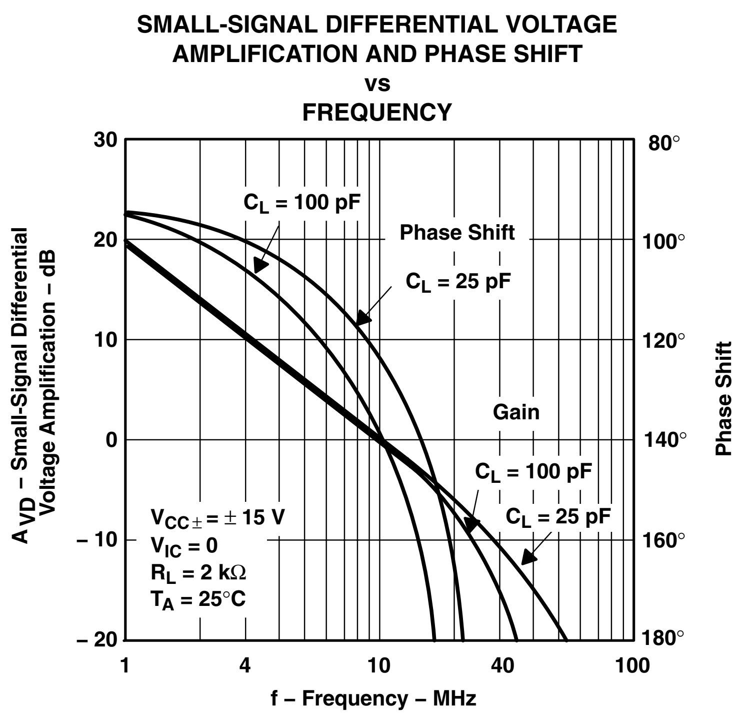


Figure 29

TYPICAL CHARACTERISTICS

COMMON-MODE REJECTION RATIO vs FREQUENCY

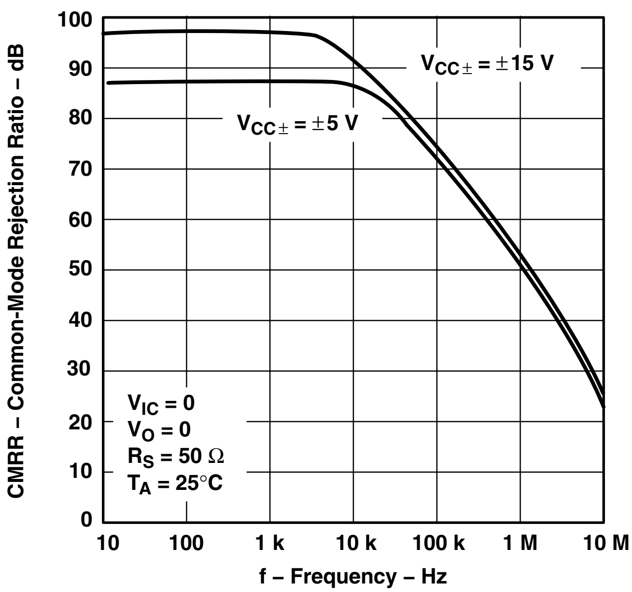


Figure 30

COMMON-MODE REJECTION RATIO† vs FREE-AIR TEMPERATURE

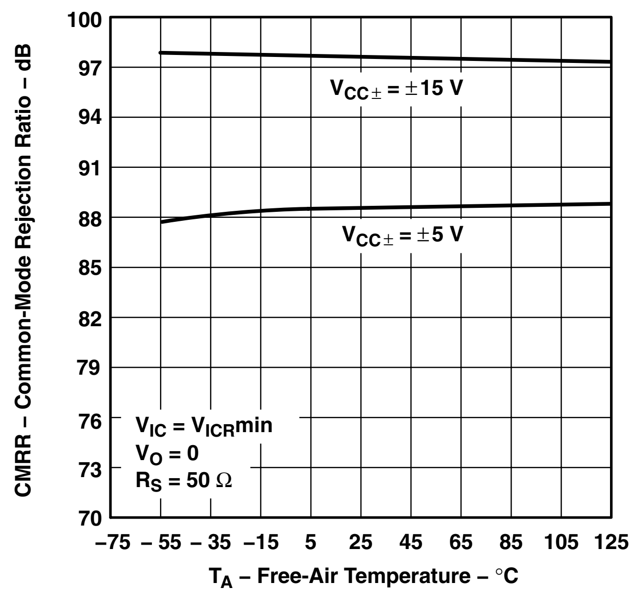


Figure 31

SUPPLY-VOLTAGE REJECTION RATIO vs FREQUENCY

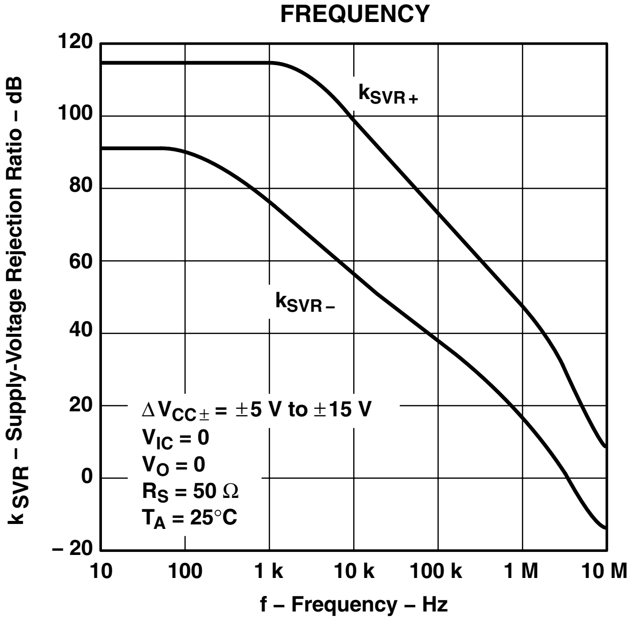


Figure 32

SUPPLY-VOLTAGE REJECTION RATIO† vs FREE-AIR TEMPERATURE

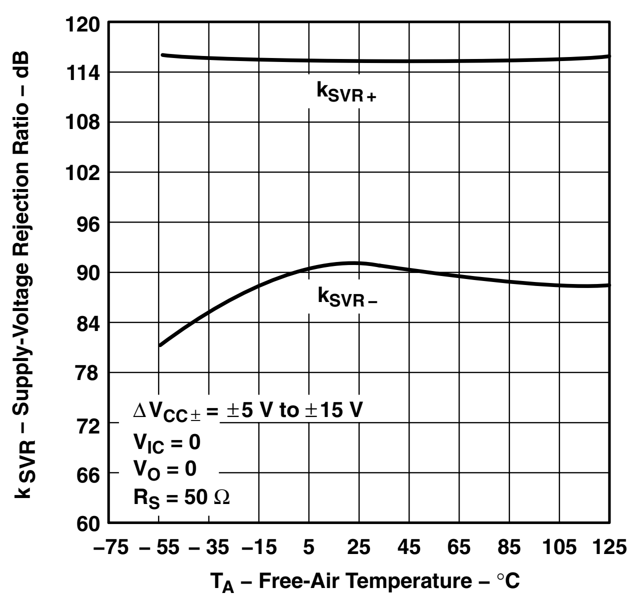


Figure 33

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

TYPICAL CHARACTERISTICS

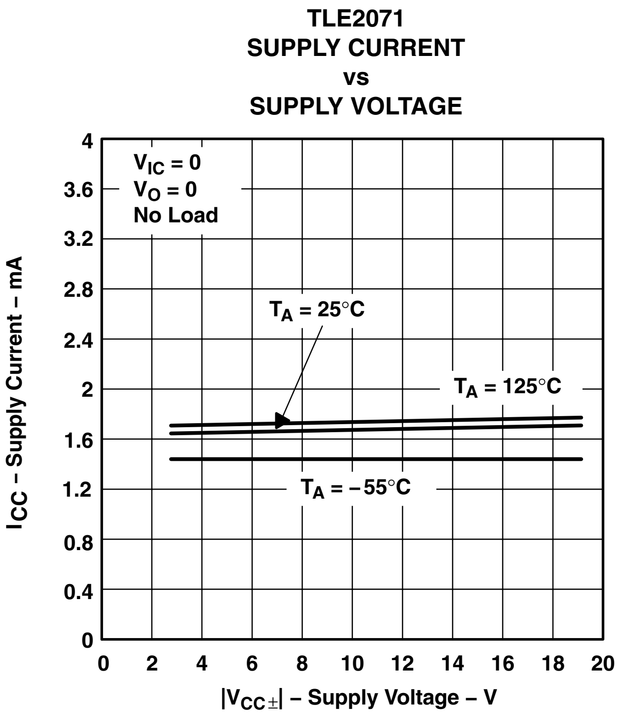


Figure 34

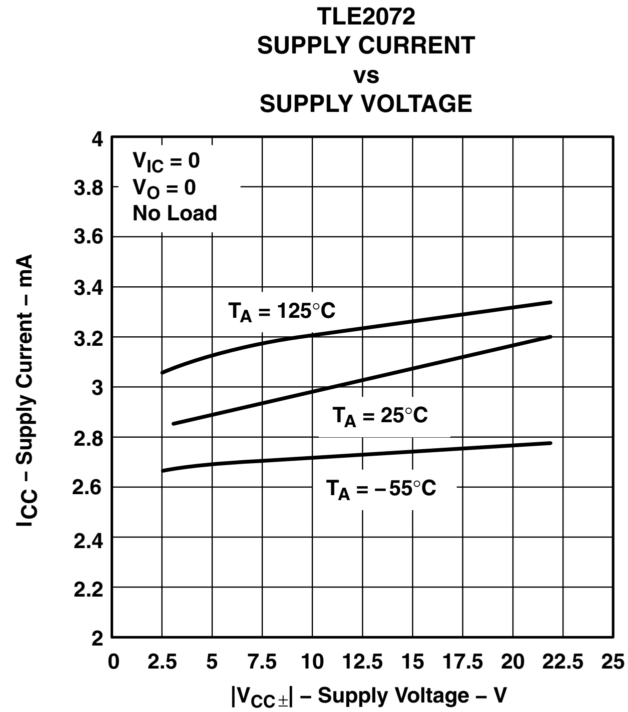


Figure 35

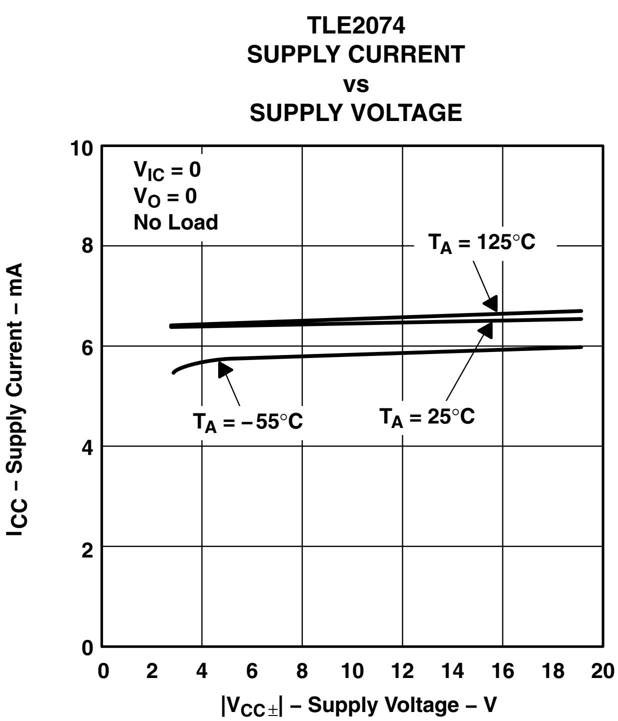


Figure 36

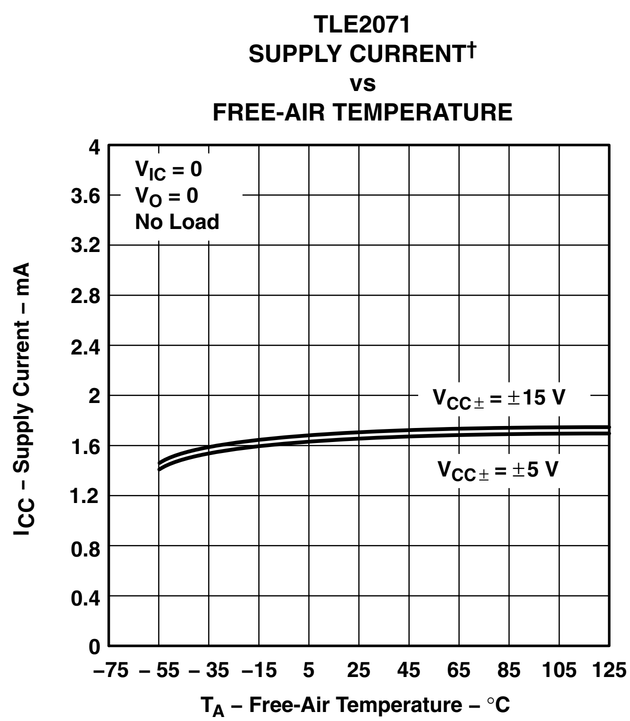


Figure 37

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

TYPICAL CHARACTERISTICS

**TLE2072
SUPPLY CURRENT†
vs
FREE-AIR TEMPERATURE**

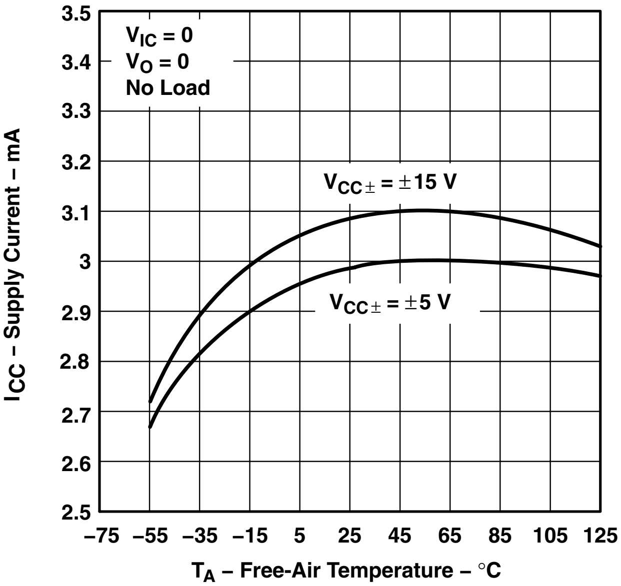


Figure 38

**TLE2074
SUPPLY CURRENT†
vs
FREE-AIR TEMPERATURE**

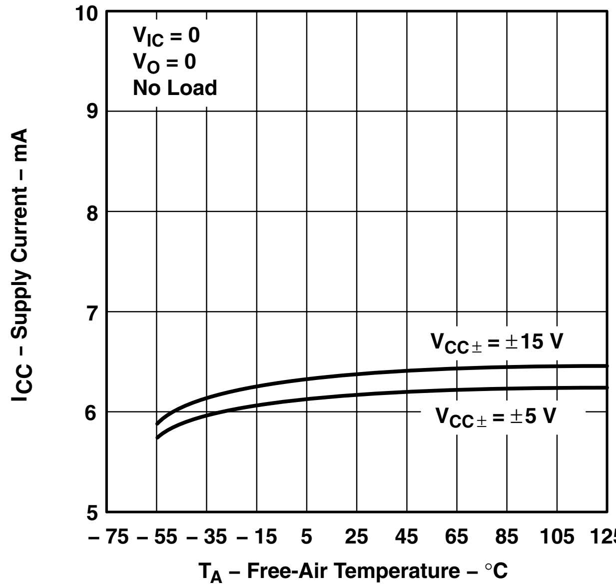


Figure 39

**TLE2071
SUPPLY CURRENT
vs
DIFFERENTIAL INPUT VOLTAGE**

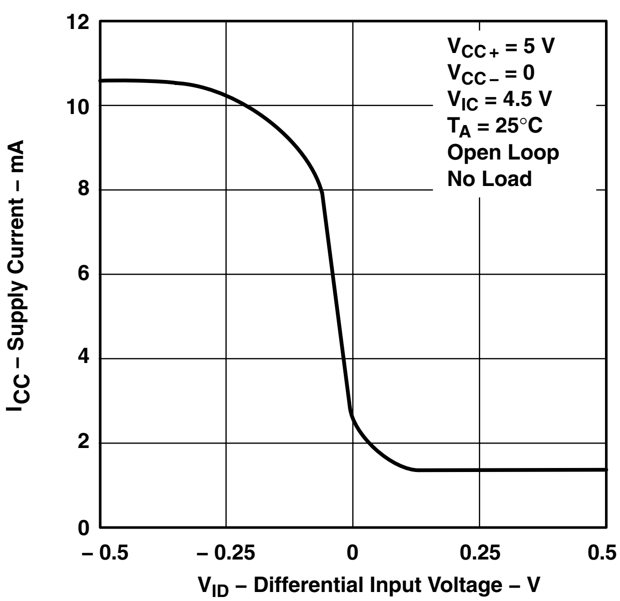


Figure 40

**TLE2072
SUPPLY CURRENT
vs
DIFFERENTIAL INPUT VOLTAGE**

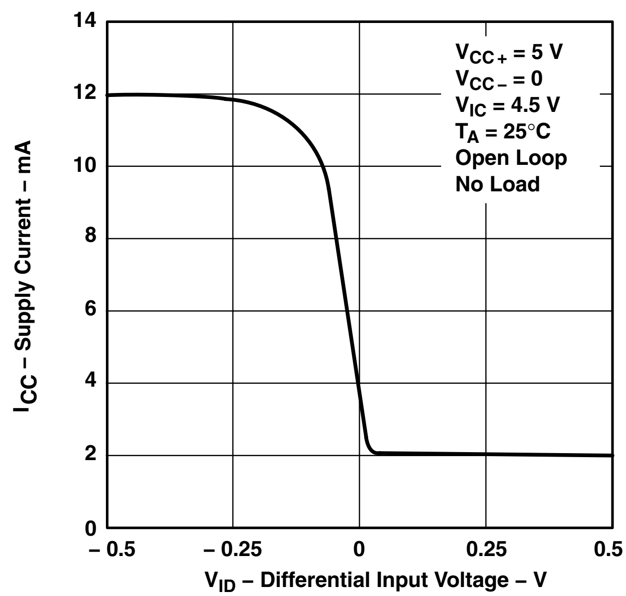


Figure 41

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

TYPICAL CHARACTERISTICS

**TLE2074
SUPPLY CURRENT
vs
DIFFERENTIAL INPUT VOLTAGE**

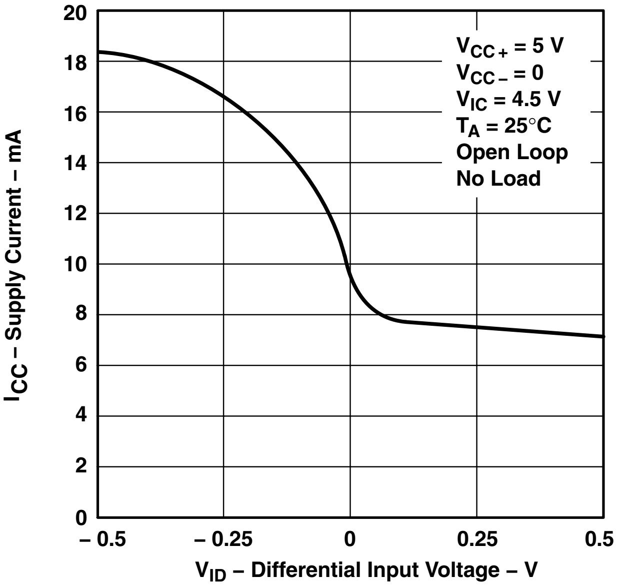


Figure 42

**TLE2071
SUPPLY CURRENT
vs
DIFFERENTIAL INPUT VOLTAGE**

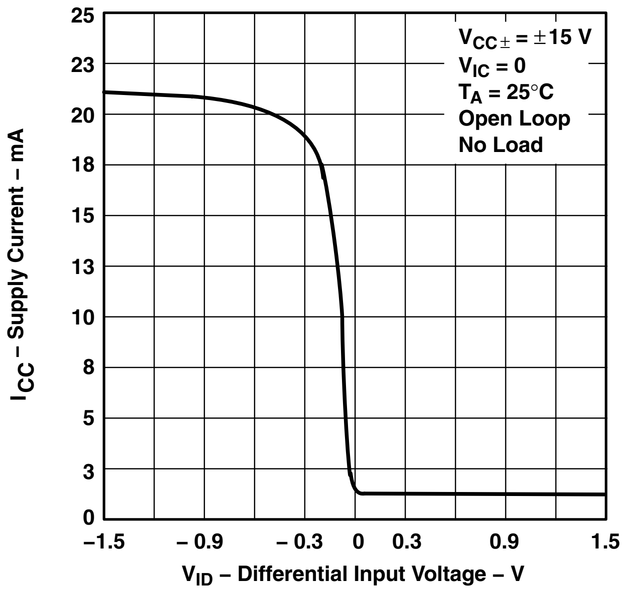


Figure 43

**TLE2072
SUPPLY CURRENT
vs
DIFFERENTIAL INPUT VOLTAGE**

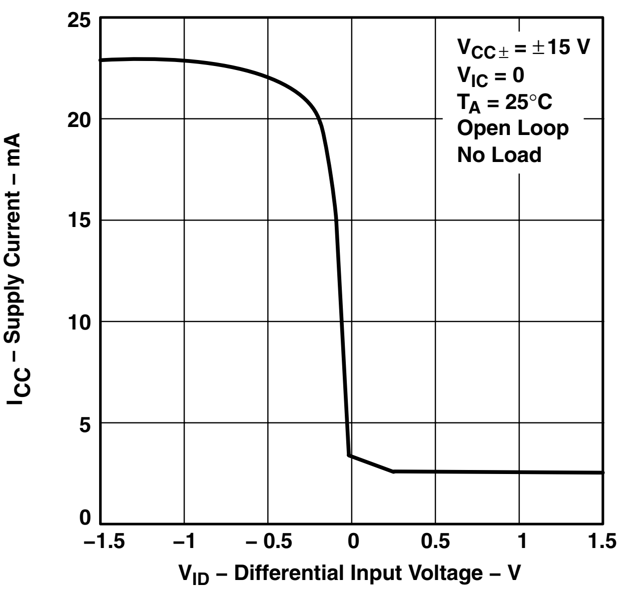


Figure 44

**TLE2074
SUPPLY CURRENT
vs
DIFFERENTIAL INPUT VOLTAGE**

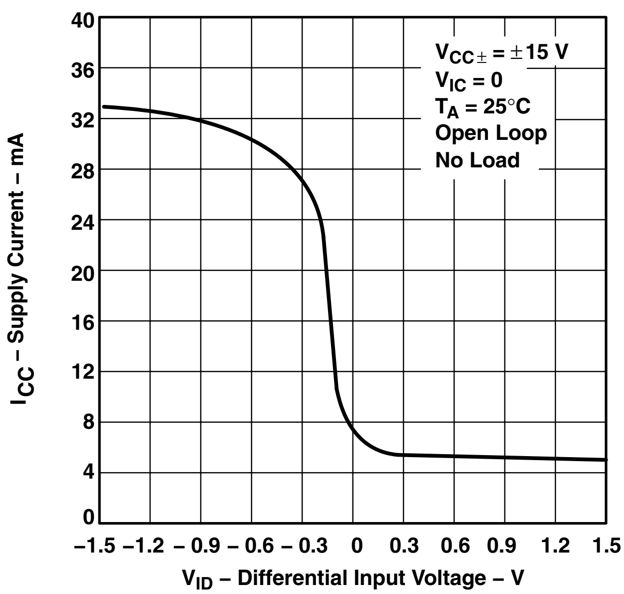


Figure 45

TYPICAL CHARACTERISTICS

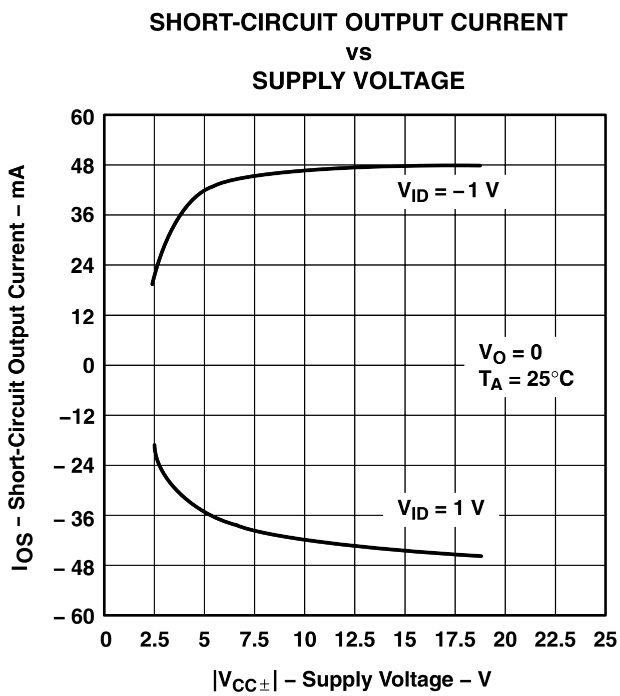


Figure 46

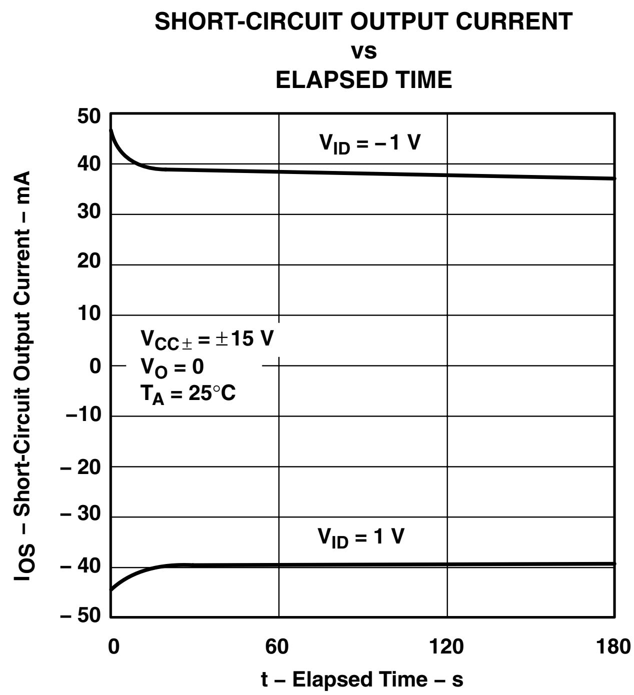


Figure 47

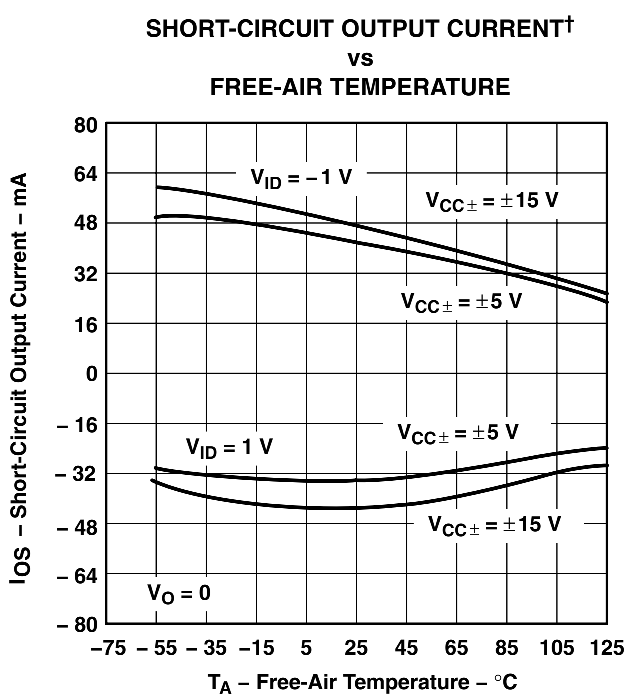


Figure 48

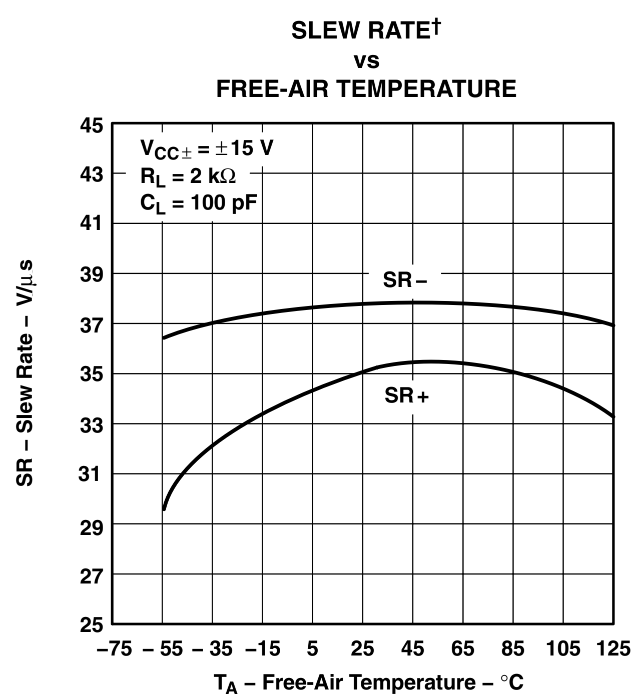


Figure 49

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

TYPICAL CHARACTERISTICS

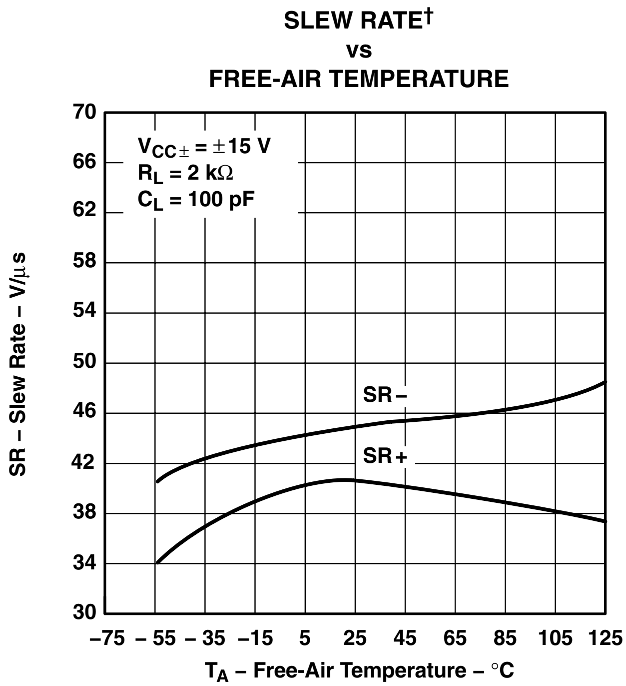


Figure 50

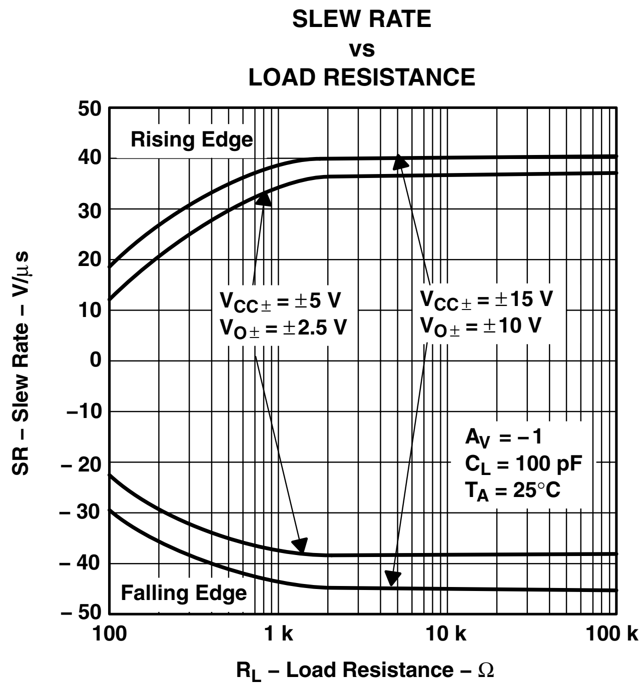


Figure 51

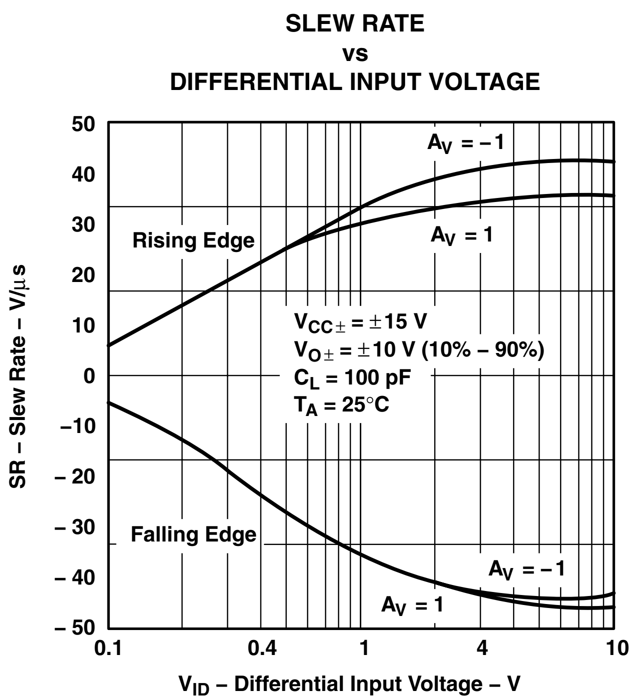


Figure 52

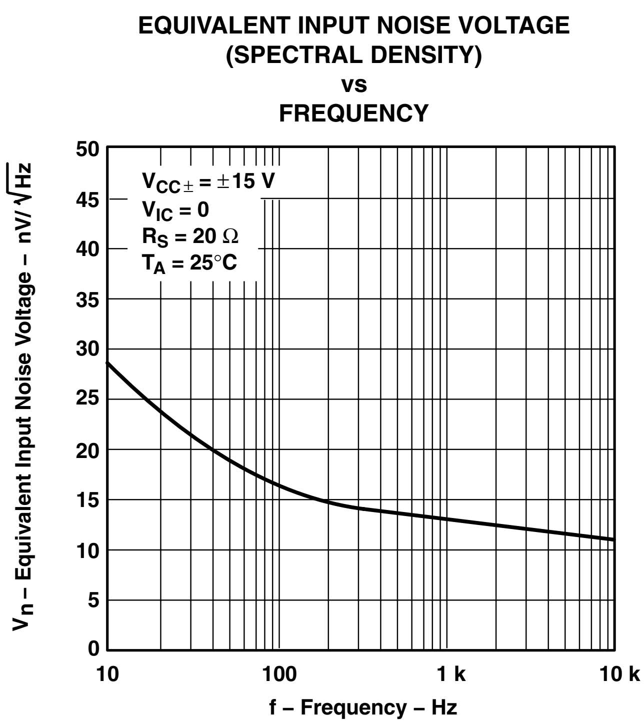


Figure 53

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

TYPICAL CHARACTERISTICS

INPUT-REFERRED NOISE VOLTAGE
vs
NOISE BANDWIDTH

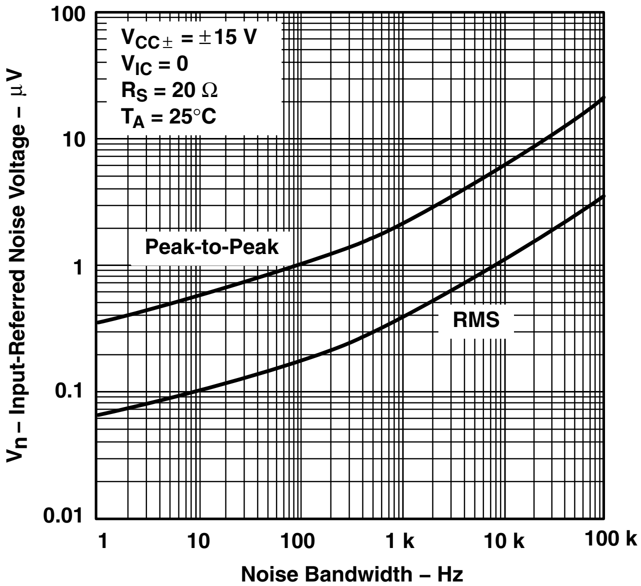


Figure 54

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

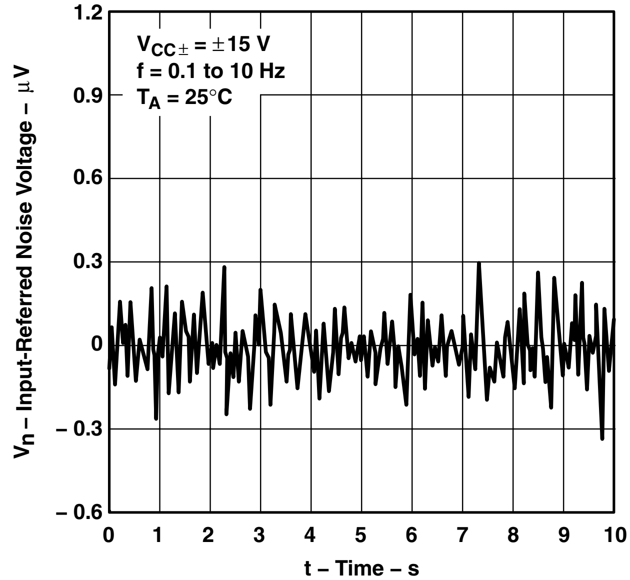


Figure 55

THIRD-OCTAVE SPECTRAL NOISE DENSITY
vs
FREQUENCY BANDS

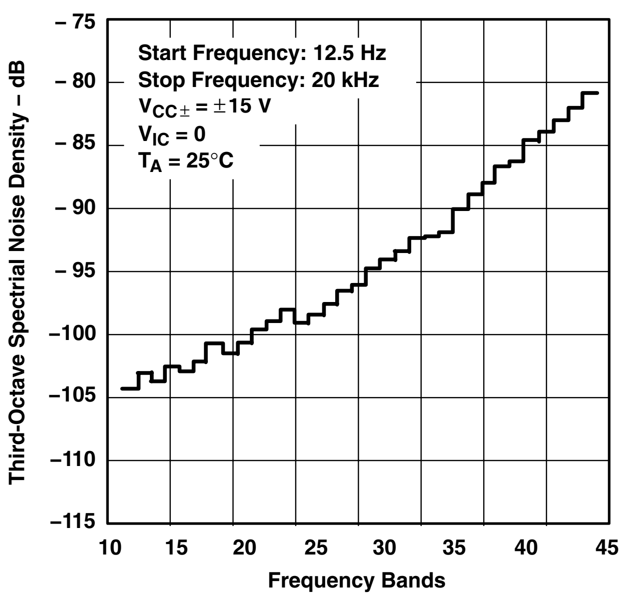


Figure 56

TOTAL HARMONIC DISTORTION PLUS NOISE
vs
FREQUENCY

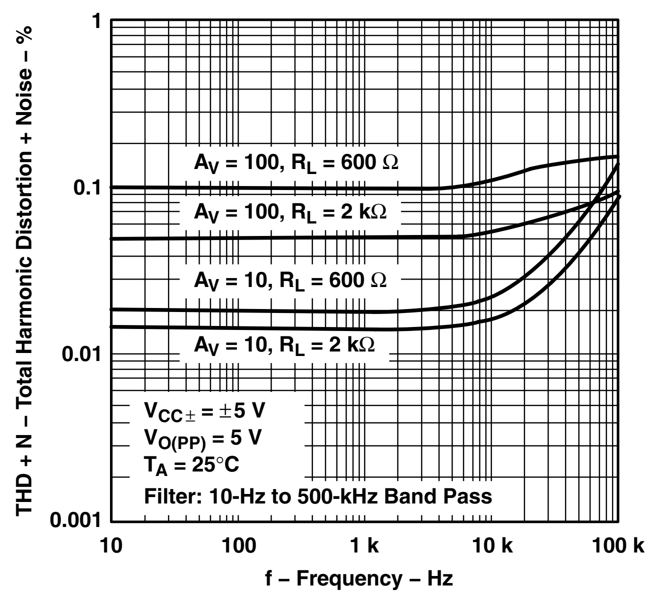


Figure 57

TYPICAL CHARACTERISTICS

TOTAL HARMONIC DISTORTION PLUS NOISE
vs
FREQUENCY

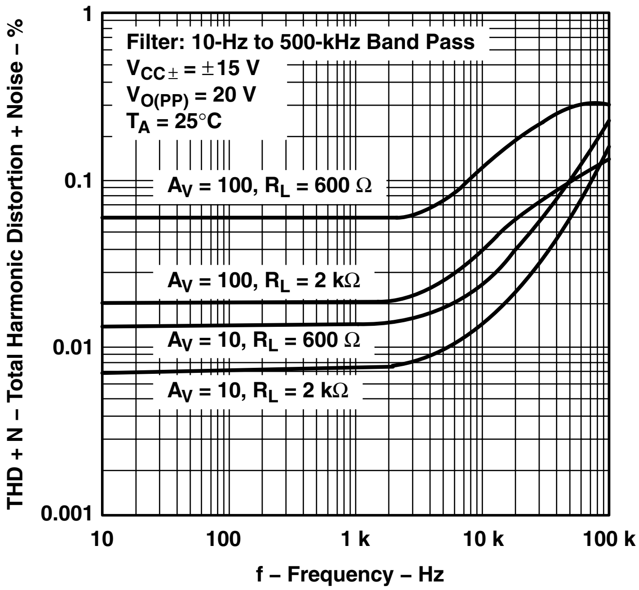


Figure 58

UNITY-GAIN BANDWIDTH
vs
LOAD CAPACITANCE

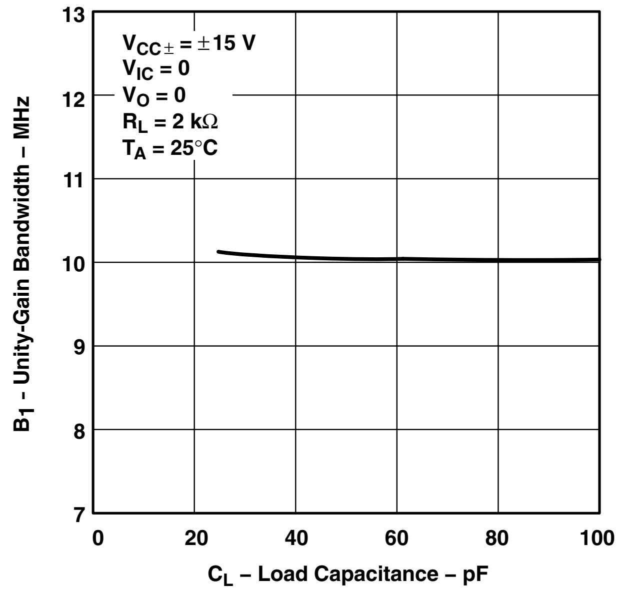


Figure 59

GAIN-BANDWIDTH PRODUCT†
vs
FREE-AIR TEMPERATURE

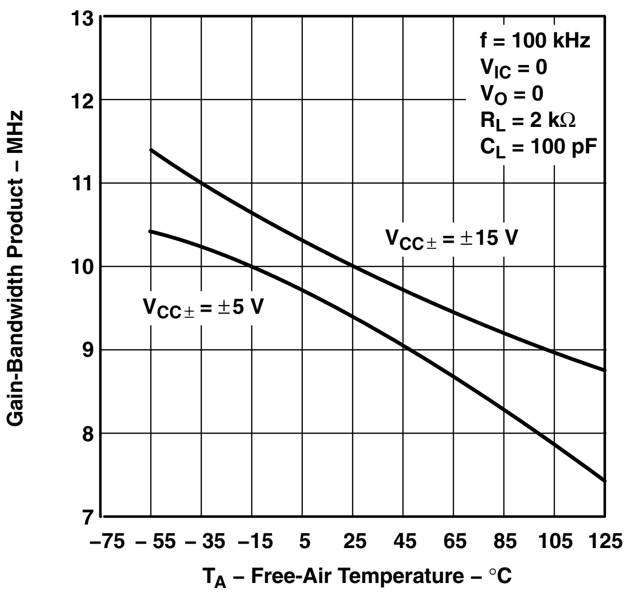


Figure 60

GAIN-BANDWIDTH PRODUCT
vs
SUPPLY VOLTAGE

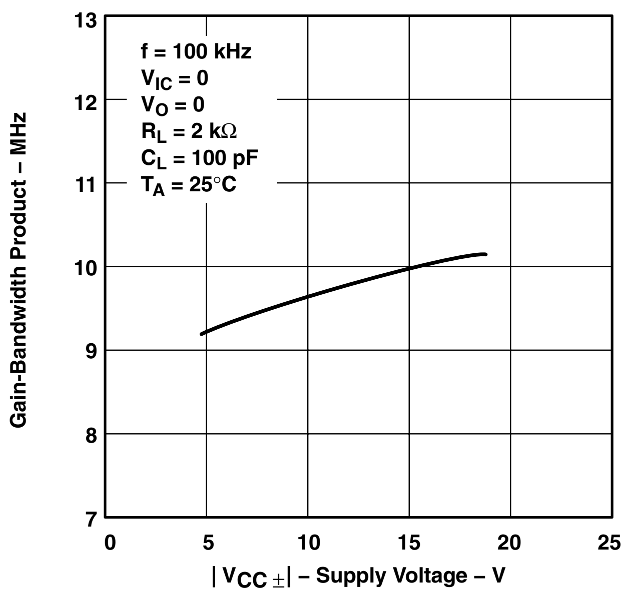


Figure 61

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

TYPICAL CHARACTERISTICS

GAIN MARGIN vs LOAD CAPACITANCE

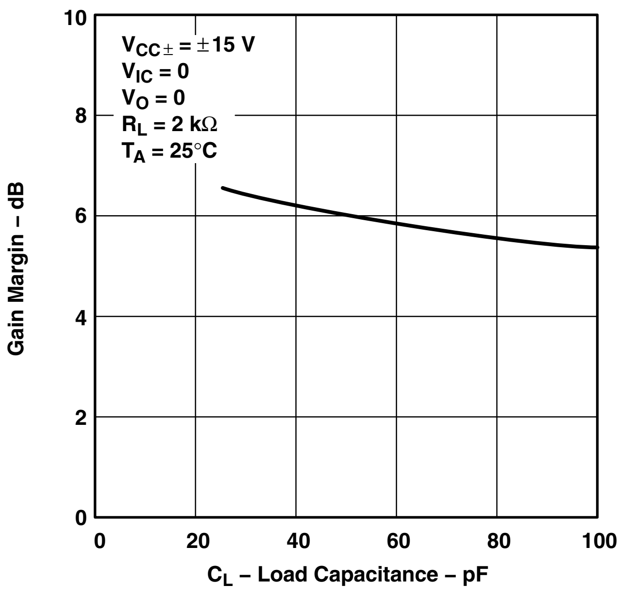


Figure 62

PHASE MARGIN† vs FREE-AIR TEMPERATURE

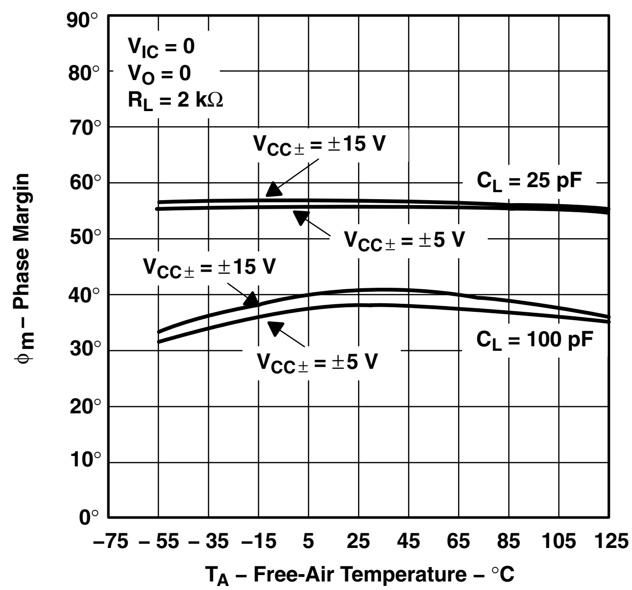


Figure 63

PHASE MARGIN vs SUPPLY VOLTAGE

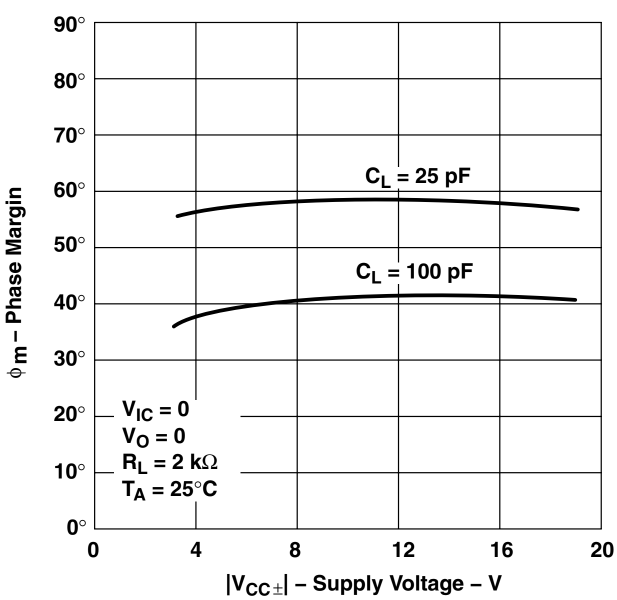


Figure 64

PHASE MARGIN vs LOAD CAPACITANCE

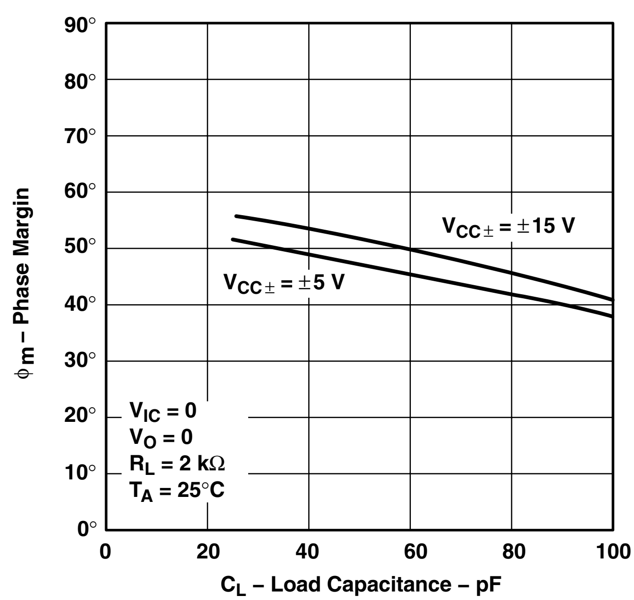


Figure 65

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

TYPICAL CHARACTERISTICS

NONINVERTING LARGE-SIGNAL PULSE RESPONSE†

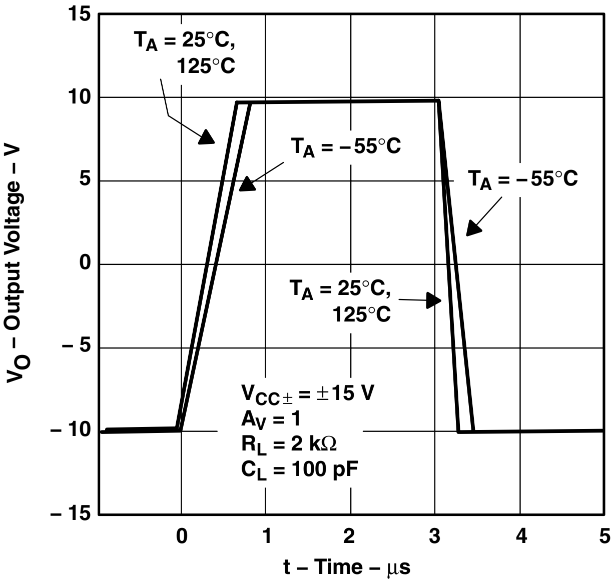


Figure 66

SMALL-SIGNAL PULSE RESPONSE

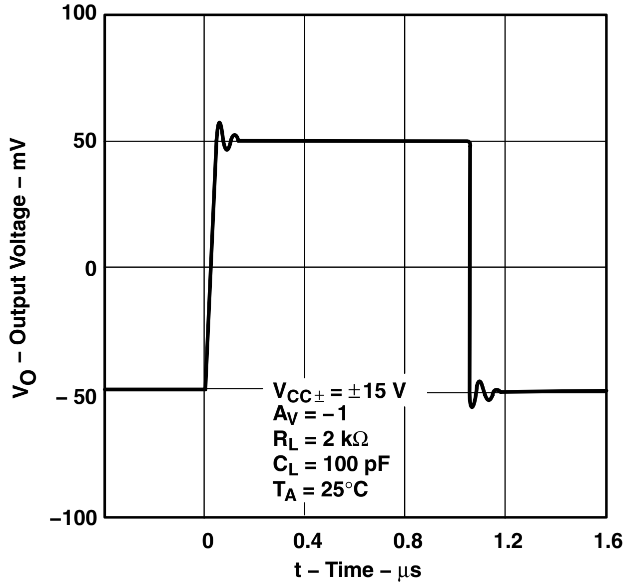


Figure 67

CLOSED-LOOP OUTPUT IMPEDANCE vs FREQUENCY

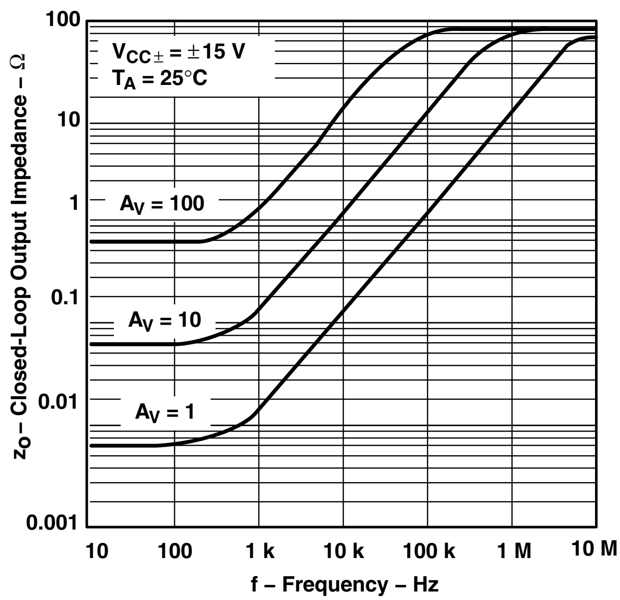


Figure 68

TLE2072 AND TLE2074 CROSSTALK ATTENUATION vs FREQUENCY

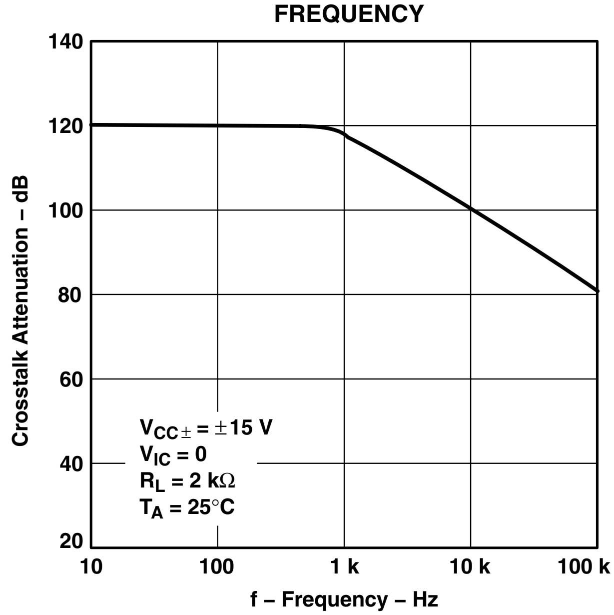


Figure 69

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

APPLICATION INFORMATION

input characteristics

The TLE207x, TLE207xA, and TLE207xB are specified with a minimum and a maximum input voltage that if exceeded at either input could cause the device to malfunction. Because of the extremely high input impedance and resulting low bias current requirements, the TLE207x, TLE207xA, and TLE207xB are well suited for low-level signal processing; however, leakage currents on printed-circuit boards and sockets can easily exceed bias current requirements and cause degradation in system performance. It is good practice to include guard rings around inputs (see Figure 70). These guards should be driven from a low-impedance source at the same voltage level as the common-mode input.

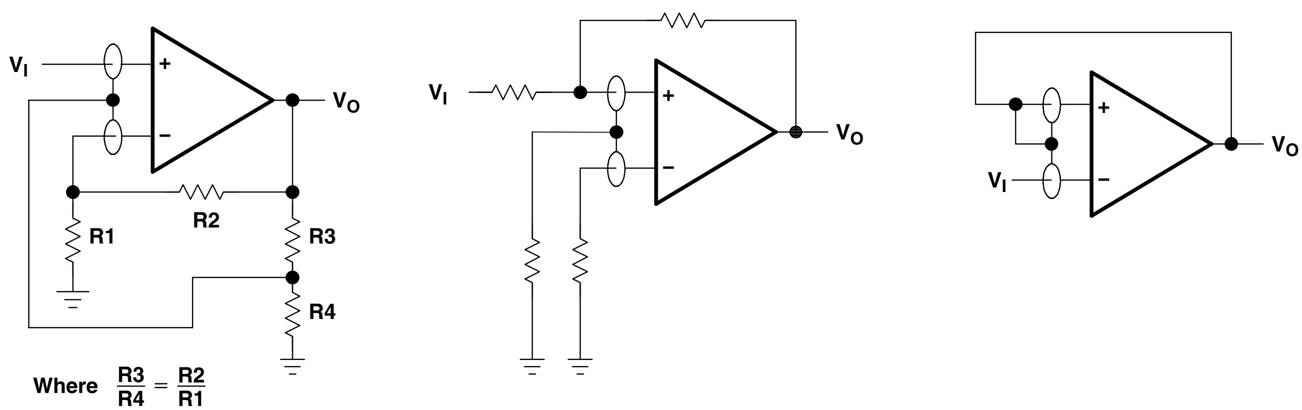


Figure 70. Use of Guard Rings

TLE2071 input offset voltage nulling

The TLE2071 series offers external null pins that can be used to further reduce the input offset voltage. The circuit of Figure 71 can be connected as shown if the feature is desired. When external nulling is not needed, the null pins may be left unconnected.

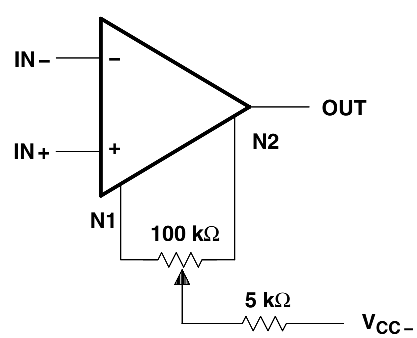


Figure 71. Input Offset Voltage Nulling

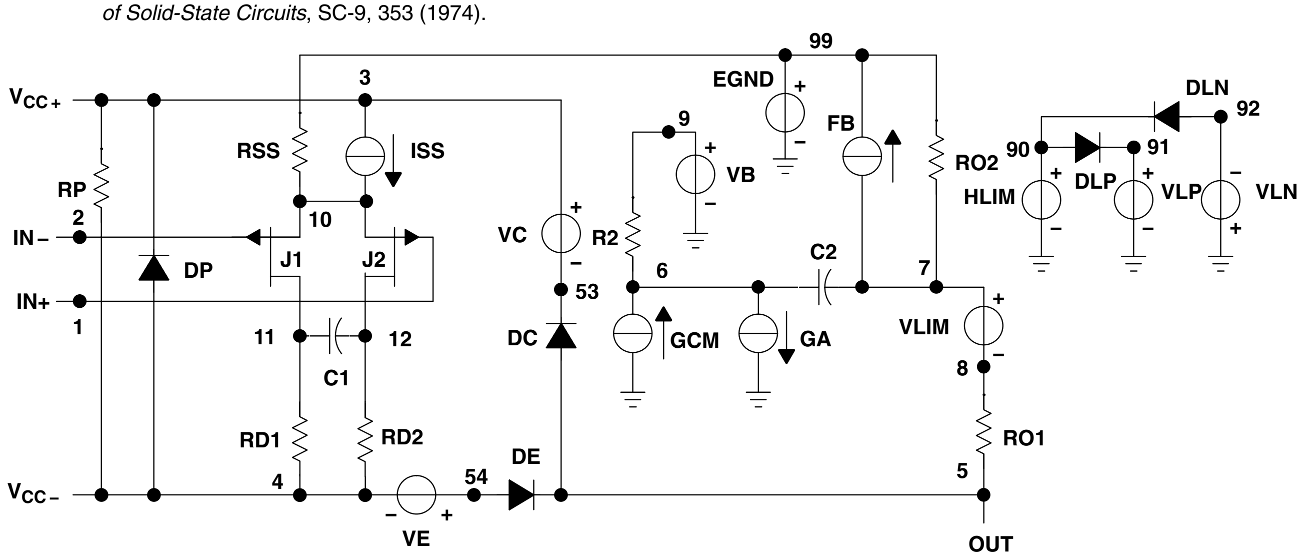
APPLICATION INFORMATION

macromodel information

Macromodel information provided was derived using *PSpice*™ *Parts*™ model generation software. The Boyle macromodel (see Note 4) and subcircuit Figure 72 were generated using the TLE207x 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 TLE2074 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 72. Boyle Macromodel and Subcircut

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
TLE2071AQDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLE2071AQDRQ1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLE2071QDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLE2071QDRQ1	OBSOLETE	SOIC	D	8		TBD	Call TI	Call TI	
TLE2072AQDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLE2072AQDRQ1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLE2072QDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLE2072QDRQ1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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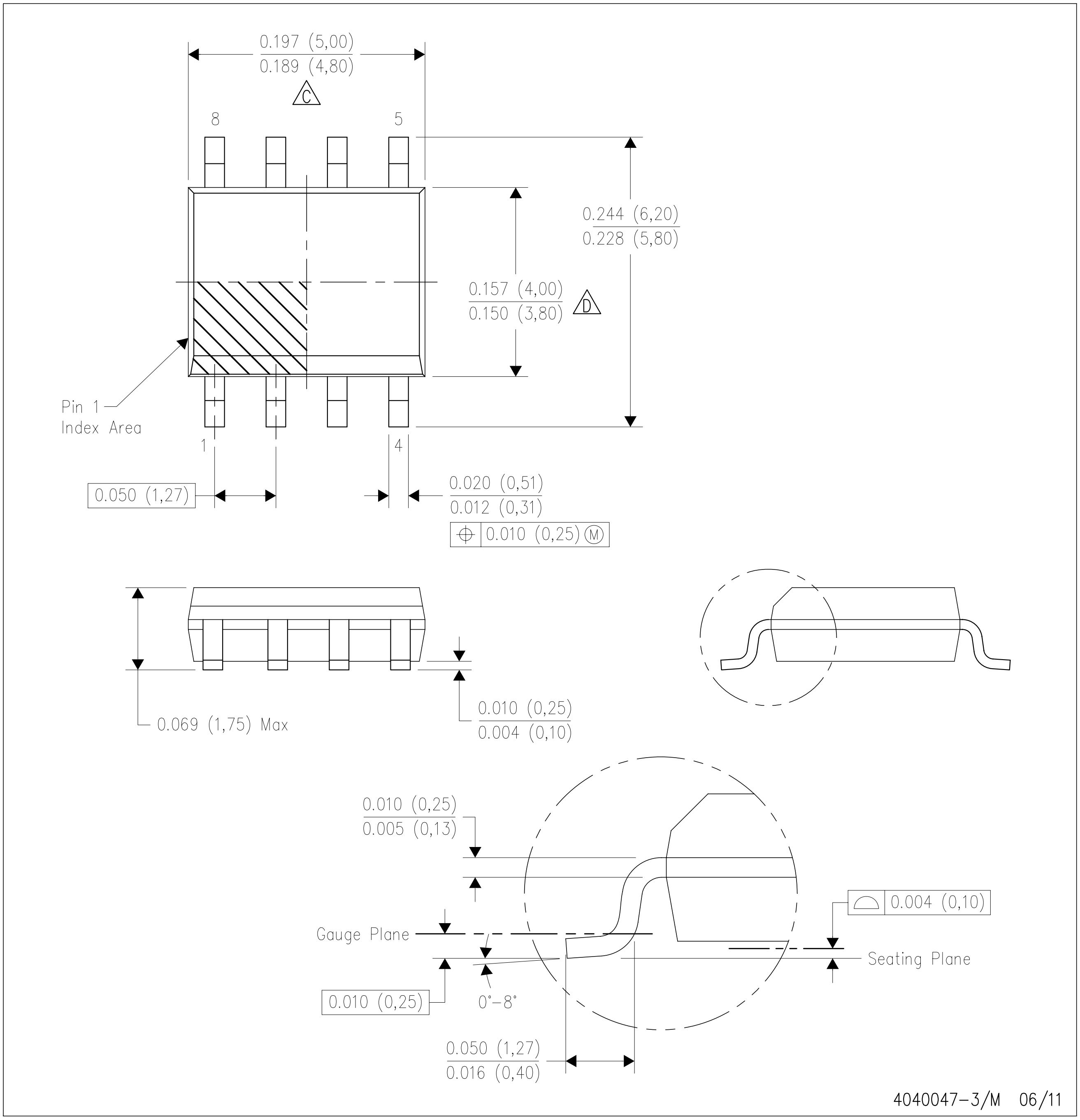
OTHER QUALIFIED VERSIONS OF TLE2071-Q1, TLE2071A-Q1, TLE2072-Q1, TLE2072A-Q1 :

- Catalog: TLE2071, TLE2071A, TLE2072, TLE2072A
- Military: TLE2071M, TLE2071AM, TLE2072M, TLE2072AM

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

D (R–PDSO–G8) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS-012 variation AA.

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