

TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

SGLS226B – DECEMBER 2003 – REVISED MAY 2008

- 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/ μ s) Than TL07x
- Ensured Maximum Noise Floor 17 nV/ $\sqrt{\text{Hz}}$
- 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/ $\sqrt{\text{Hz}}$, 17-nV/ $\sqrt{\text{Hz}}$ 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



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

**TEXAS
INSTRUMENTS**

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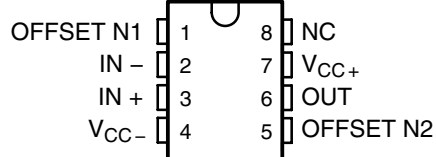
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description/ordering information (continued)

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.

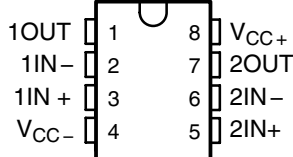
TLE2071 AND TLE2071A

**D PACKAGE
(TOP VIEW)**



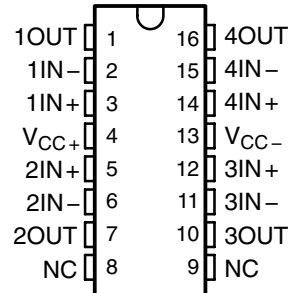
TLE2072 AND TLE2072A

**D PACKAGE
(TOP VIEW)**



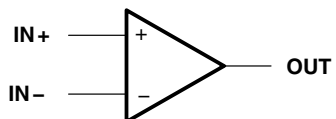
TLE2074 AND TLE2074A

**DW PACKAGE
(TOP VIEW)**



NC – No internal connection

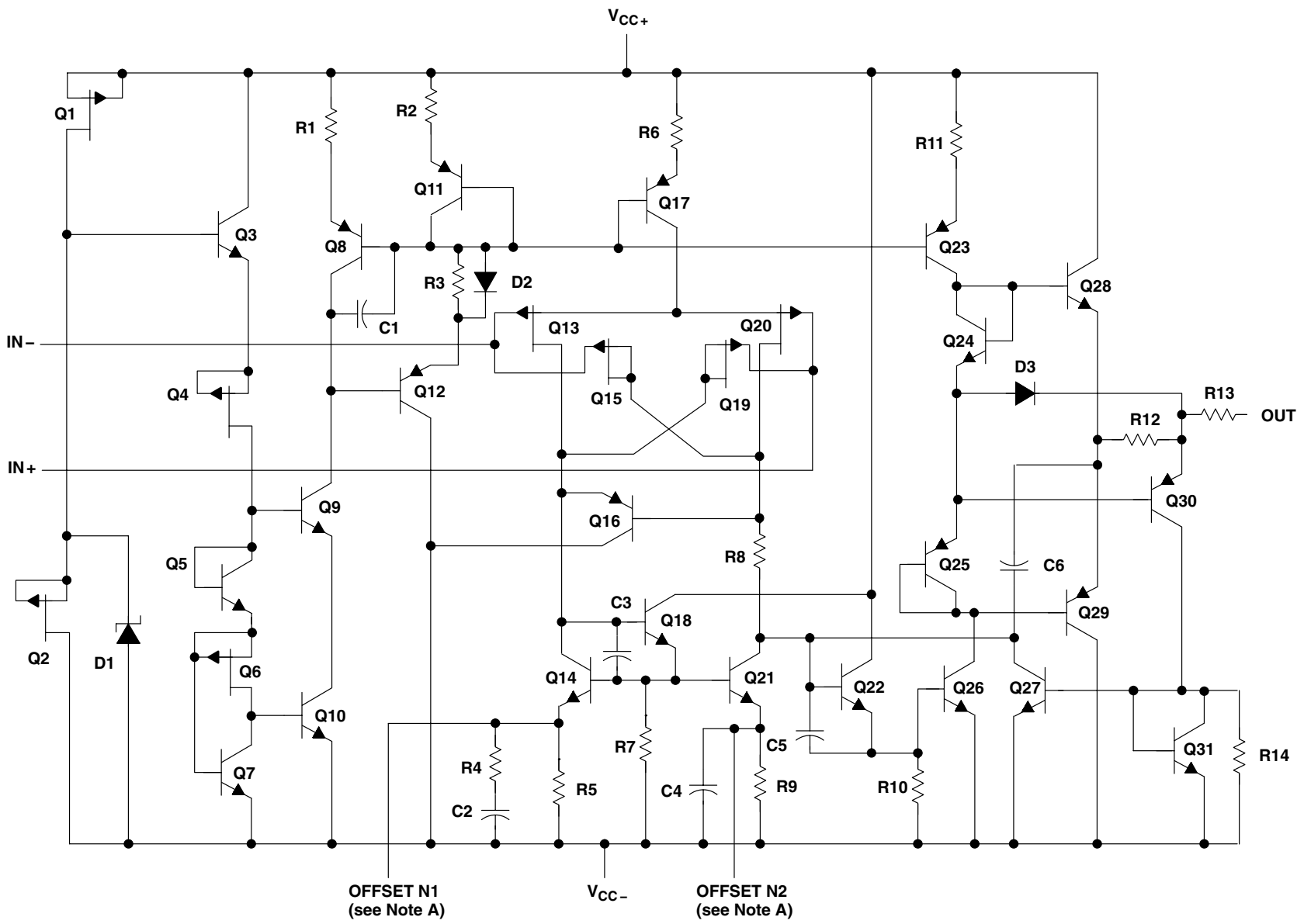
symbol



TLE207x-Q1, TLE207xA-Q1
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SLOS181A – FEBRUARY 1997 – REVISED MARCH 2000 (sourced from

equivalent schematic



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

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SLOS181A – FEBRUARY 1997 – REVISED MARCH 2000 (sourced from)

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

equivalent schematic (continued)

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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

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.

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

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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	0.34	4		0.3	2		mV
		Full range			9			7	
α_{VIO} Temperature coefficient of input offset voltage		Full range	3.2			3.2	20		$\mu V/^\circ C$
I_{IO} Input offset current	$V_{IC} = 0, V_O = 0, \text{See Figure 4}$	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	$R_S = 50 \Omega$	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	3.6			3.6			
	$I_O = -2 \text{ mA}$	25°C	3.5	3.9		3.5	3.9		
		Full range	3.3			3.3			
	$I_O = -20 \text{ mA}$	25°C	1.5	2.3		1.5	2.3		
		Full range	1.4			1.4			
V_{OM-} Maximum negative peak output voltage swing	$I_O = 200 \mu A$	25°C	-3.8	-4.2		-3.8	-4.2		V
		Full range	-3.6			-3.6			
	$I_O = 2 \text{ mA}$	25°C	-3.5	-4.1		-3.5	-4.1		
		Full range	-3.3			-3.3			
	$I_O = 20 \text{ mA}$	25°C	-1.5	-2.4		-1.5	-2.4		
		Full range	-1.4			-1.4			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 2.3 \text{ V}$	$R_L = 600 \Omega$	25°C	80	91	80	91		dB
			Full range	78		78			
		$R_L = 2 \text{ k}\Omega$	25°C	90	100	90	100		
			Full range	88		88			
		$R_L = 10 \text{ k}\Omega$	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	$V_{IC} = 0, \text{See Figure 5}$	Common mode	25°C	11		11			pF
		Differential	25°C	2.5		2.5			
z_o Open-loop output impedance	$f = 1 \text{ MHz}$	25°C		80			80		Ω
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50 \Omega$	25°C	70	89		70	89		dB
		Full range	68			68			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{CC\pm} / \Delta V_{IO}$)	$V_{CC\pm} = \pm 5 \text{ V to } \pm 15 \text{ V}, V_O = 0, R_S = 50 \Omega$	25°C	82	99		82	99		dB
		Full range	80			80			

† Full range is $-40^\circ C$ to $125^\circ C$.



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TLE2071-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm 5$ 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	1.6	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, $V_{CC\pm} = \pm 5$ V

PARAMETER		TEST CONDITIONS		T _A [†]	TLE2071-Q1			TLE2071A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR +	Positive slew rate	V _{O(PP)} = ±2.3 V, A _{VD} = −1, R _L = 2 kΩ, C _L = 100 pF, 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.

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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		$\mu V/^\circ C$
I_{IO} Input offset current	$V_{IC} = 0, V_O = 0, \text{See Figure 4}$	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			
	$I_O = -2 \text{ mA}$	25°C	13.5	13.9		13.5	13.9		
		Full range	13.3			13.3			
	$I_O = -20 \text{ mA}$	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			
	$I_O = 2 \text{ mA}$	25°C	-13.5	-14		-13.5	-14		
		Full range	-13.3			-13.3			
	$I_O = 20 \text{ mA}$	25°C	-11.5	-12.4		-11.5	-12.4		
		Full range	-11.4			-11.4			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 10 \text{ V}$	$R_L = 600 \Omega$	25°C	80	96	80	96		dB
			Full range	78		78			
		$R_L = 2 \text{ k}\Omega$	25°C	90	109	90	109		
			Full range	88		88			
		$R_L = 10 \text{ k}\Omega$	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	$V_{IC} = 0, \text{See Figure 5}$	Common mode	25°C	7.5		7.5			pF
		Differential	25°C	2.5		2.5			
z_o Open-loop output impedance	$f = 1 \text{ MHz}$	25°C		80			80		Ω
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50 \Omega$	25°C	80	98		80	98		dB
		Full range	78			78			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm 5 \text{ V to } \pm 15 \text{ V}, V_O = 0, R_S = 50 \Omega$	25°C	82	99		82	99		dB
		Full range	80			80			

† Full range is $-40^\circ C$ to $125^\circ C$.



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TLE2071-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm 15$ 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, $V_{CC\pm} = \pm 15$ 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, A _{VD} = −1, R _L = 2 kΩ, C _L = 100 pF, See Figure 1		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, A _{VD} = 10, f = 1 kHz, R _S = 25 Ω	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.

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLE2072-Q1			TLE2072A-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	0.9	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		$\mu V/^\circ C$
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	$R_S = 50 \Omega$	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	3.6			3.6			
	$I_O = -2 \text{ mA}$	25°C	3.5	3.9		3.5	3.9		
		Full range	3.3			3.3			
	$I_O = -20 \text{ mA}$	25°C	1.5	2.3		1.5	2.3		
		Full range	1.4			1.4			
V_{OM-} Maximum negative peak output voltage swing	$I_O = 200 \mu A$	25°C	-3.8	-4.2		-3.8	-4.2		V
		Full range	-3.6			-3.6			
	$I_O = 2 \text{ mA}$	25°C	-3.5	-4.1		-3.5	-4.1		
		Full range	-3.3			-3.3			
	$I_O = 20 \text{ mA}$	25°C	-1.5	-2.4		-1.5	-2.4		
		Full range	-1.4			-1.4			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 2.3 \text{ V}$	$R_L = 600 \Omega$	25°C	80	91	80	91		dB
			Full range	78		78			
		$R_L = 2 \text{ k}\Omega$	25°C	90	100	90	100		
			Full range	88		88			
		$R_L = 10 \text{ k}\Omega$	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	$f = 1 \text{ MHz}$	25°C		80			80		Ω
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin},$ $V_O = 0, R_S = 50 \Omega$	25°C	70	89		70	89		dB
		Full range	68			68			

† Full range is $-40^\circ C$ to $125^\circ C$.



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TLE207x-Q1, TLE207xA-Q1
EXCALIBUR LOW-NOISE HIGH-SPEED
JFET-INPUT OPERATIONAL AMPLIFIERS

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

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

PARAMETER		TEST CONDITIONS		T _A [†]	TLE2072-Q1			TLE2072A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
k _{SVR}	Supply-voltage rejection ratio (ΔV _{CC±} /ΔV _{IO})	V _{CC±} = ±5 V to ±15 V, V _O = 0, R _S = 50 Ω		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 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			

† Full range is -40°C to 125°C.

TLE2072-Q1 operating characteristics at specified free-air temperature, $V_{CC\pm} = \pm 5$ V

PARAMETER		TEST CONDITIONS		T _A [†]	TLE2072-Q1			TLE2072A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR +	Positive slew rate	V _{O(PP)} = ±2.3 V, A _{VD} = -1, C _L = 100 pF, 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 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.



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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLE2072-Q1			TLE2072A-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	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		$\mu V/^\circ C$
I_{IO} Input offset current	$V_{IC} = 0, V_O = 0, \text{See Figure 4}$	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			
	$I_O = -2\ \text{mA}$	25°C	13.5	13.9		13.5	13.9		
		Full range	13.3			13.3			
	$I_O = -20\ \text{mA}$	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			
	$I_O = 2\ \text{mA}$	25°C	-13.5	-14		-13.5	-14		
		Full range	-13.3			-13.3			
	$I_O = 20\ \text{mA}$	25°C	-11.5	-12.4		-11.5	-12.4		
		Full range	-11.4			-11.4			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 10\ \text{V}$	$R_L = 600\ \Omega$	25°C	80	96	80	96		dB
			Full range	78		78			
		$R_L = 2\ \text{k}\Omega$	25°C	90	109	90	109		
			Full range	89		89			
		$R_L = 10\ \text{k}\Omega$	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	$V_{IC} = 0, \text{See Figure 5}$	Common mode	25°C	7.5		7.5			pF
		Differential	25°C	2.5		2.5			
z_o Open-loop output impedance	$f = 1\ \text{MHz}$	25°C		80			80		Ω
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\ \Omega$	25°C	80	98		80	98		dB
		Full range	78			78			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm 5\ \text{V to } \pm 15\ \text{V}, V_O = 0, R_S = 50\ \Omega$	25°C	82	99		82	99		dB
		Full range	80			80			

† Full range is -40°C to 125°C .



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TLE2072-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm 15$ 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, $V_{CC\pm} = \pm 15$ 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, A _{VD} = −1, R _L = 2 kΩ, C _L = 100 pF, See Figure 1		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	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 .

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TLE2074-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm 5$ V (unless otherwise noted)

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLE2074-Q1			TLE2074A-Q1			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, V_O = 0, R_S = 50\Omega$	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		$\mu V/^\circ C$
I_{IO} Input offset current	$V_{IC} = 0, V_O = 0, \text{See Figure 4}$	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	$R_S = 50\Omega$	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	3.6			3.6			
	$I_O = -2\text{ mA}$	25°C	3.5	3.9		3.5	3.9		
		Full range	3.3			3.3			
	$I_O = -20\text{ mA}$	25°C	1.5	2.3		1.5	2.3		
		Full range	1.4			1.4			
V_{OM-} Maximum negative peak output voltage swing	$I_O = 200\mu A$	25°C	-3.8	-4.2		-3.8	-4.2		V
		Full range	-3.6			-3.6			
	$I_O = 2\text{ mA}$	25°C	-3.5	-4.1		-3.5	-4.1		
		Full range	-3.3			-3.3			
	$I_O = 20\text{ mA}$	25°C	-1.5	-2.4		-1.5	-2.4		
		Full range	-1.4			-1.4			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 2.3\text{ V}$	$R_L = 600\Omega$	25°C	80	91	80	91		dB
			Full range	78		78			
		$R_L = 2\text{ k}\Omega$	25°C	90	100	90	100		
			Full range	88		88			
		$R_L = 10\text{ k}\Omega$	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	25°C		11		11			pF
	Differential	25°C		2.5		2.5			
z_o Open-loop output impedance	$f = 1\text{ MHz}$	25°C		80		80			Ω
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\Omega$	25°C	70	89		70	89		dB
		Full range	68			68			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{CC\pm} / \Delta V_{IO}$)	$V_{CC\pm} = \pm 5\text{ V to } \pm 15\text{ V}, V_O = 0, R_S = 50\Omega$	25°C	82	99		82	99		dB
		Full range	80			80			

† Full range is $-40^\circ C$ to $125^\circ C$.

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TLE2074-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm 5$ V (unless otherwise noted) (continued)

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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 Ω	25°C		120			120		dB
I_{OS} Short-circuit output current	$V_O = 0$	$V_{ID} = 1$ V		–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, $V_{CC\pm} = \pm 5$ V

PARAMETER		TEST CONDITIONS		T _A [†]	TLE2074-Q1			TLE2074A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	V _{O(PP)} = ±2.3 V, A _{VD} = −1, C _L = 100 pF, R _L = 2 kΩ, 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 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
f _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.

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TLE2074-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm 15$ 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				
I _{IB}	Input bias current				25°C	25		175	25		175	pA
					Full range	60		60				
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 _{ICRmin} , V _O = 0, R _S = 50 Ω		25°C	80	98	80		98	dB	
					Full range	78	78					
k _{SVR}	Supply-voltage rejection ratio (ΔV _{CC±} /ΔV _{IO})		V _{CC±} = ±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 $-40^\circ C$ to $125^\circ C$.



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TLE2074-Q1 electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm 15$ 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 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.

TLE2074-Q1 operating characteristics at specified free-air temperature, $V_{CC\pm} = \pm 15$ V

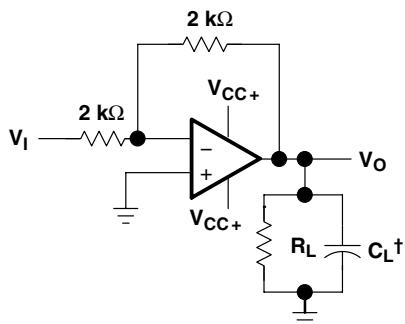
PARAMETER		TEST CONDITIONS		T _A [†]	TLE2074-Q1			TLE2074A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR +	Positive slew rate	V _{O(PP)} = 10 V, A _{VD} = −1, R _L = 2 kΩ, C _L = 100 pF, See Figure 1		25°C	25	40		25	40		V/μs
				Full range	17			17			
SR −	Negative slew rate			25°C	30	45		30	45		V/μs
				Full range	20			20			
t _s	Settling time	A _{VD} = −1, 10-V step, R _L = 1 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, A _{VD} = 10, f = 1 kHz, R _L = 2 kΩ, R _S = 25 Ω		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.

TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

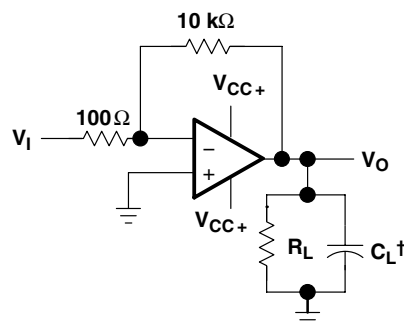
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PARAMETER MEASUREMENT INFORMATION



† Includes fixture capacitance

Figure 1. Slew-Rate Test Circuit



† Includes fixture capacitance

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

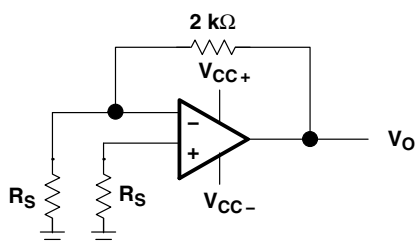


Figure 3. Noise-Voltage Test Circuit

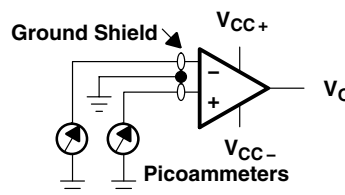


Figure 4. Input-Bias and Offset-Current Test Circuit

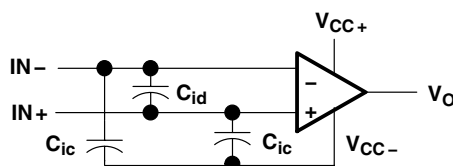


Figure 5. Internal Input Capacitance

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

Table of Graphs

			FIGURE
V_{IO}	Input offset voltage	Distribution	6, 7, 8
α_{VIO}	Temperature coefficient of input offset voltage	Distribution	9, 10, 11
I_{IO}	Input offset current	vs Free-air temperature	12, 13
I_{IB}	Input bias current	vs Free-air temperature vs Total supply voltage	12, 13 14
V_{ICR}	Common-mode input voltage range	vs Free-air temperature	15
V_O	Output voltage	vs Differential input voltage	16, 17
V_{OM+}	Maximum positive peak output voltage	vs Output current	18
V_{OM-}	Maximum negative peak output voltage	vs Output current	19
V_{OM}	Maximum peak output voltage	vs Free-air temperature vs Supply voltage	20, 21 22
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency	23
V_O	Output voltage	vs Settling time	24
A_{VD}	Large-signal differential voltage amplification	vs Load resistance vs Free-air temperature	25 26, 27
A_{VD}	Small-signal differential voltage amplification	vs Frequency	28, 29
$CMRR$	Common-mode rejection ratio	vs Frequency vs Free-air temperature	30 31
k_{SVR}	Supply-voltage rejection ratio	vs Frequency vs Free-air temperature	32 33
I_{CC}	Supply current	vs Supply voltage vs Free-air temperature vs Differential input voltage	34, 35, 36 37, 38, 39 40 – 45
I_{OS}	Short-circuit output current	vs Supply voltage vs Elapsed time vs Free-air temperature	46 47 48
SR	Slew rate	vs Free-air temperature vs Load resistance vs Differential input voltage	49, 50 51 52
V_n	Equivalent Input noise voltage (spectral density)	vs Frequency	53
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	Third-octave spectral noise density	vs Frequency bands	56
$THD + N$	Total harmonic distortion plus noise	vs Frequency	57, 58
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	Gain-bandwidth product	vs Free-air temperature vs Supply voltage	60 61
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	Phase shift	vs Frequency	28, 29
	Noninverting large-signal pulse response	vs Time	66
	Small-signal pulse response	vs Time	67
z_o	Closed-loop output impedance	vs Frequency	68
	Crosstalk attenuation	vs Frequency	69

TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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TYPICAL CHARACTERISTICS

**DISTRIBUTION OF TLE2071
INPUT OFFSET VOLTAGE**

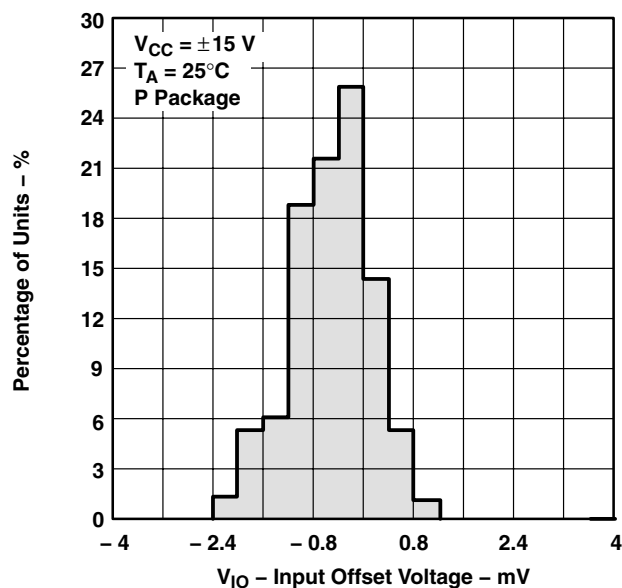


Figure 6

**DISTRIBUTION OF TLE2072
INPUT OFFSET VOLTAGE**

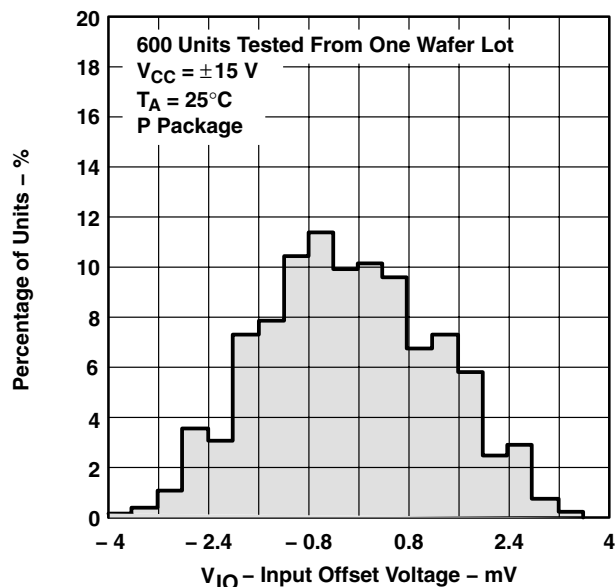


Figure 7

**DISTRIBUTION OF TLE2074
INPUT OFFSET VOLTAGE**

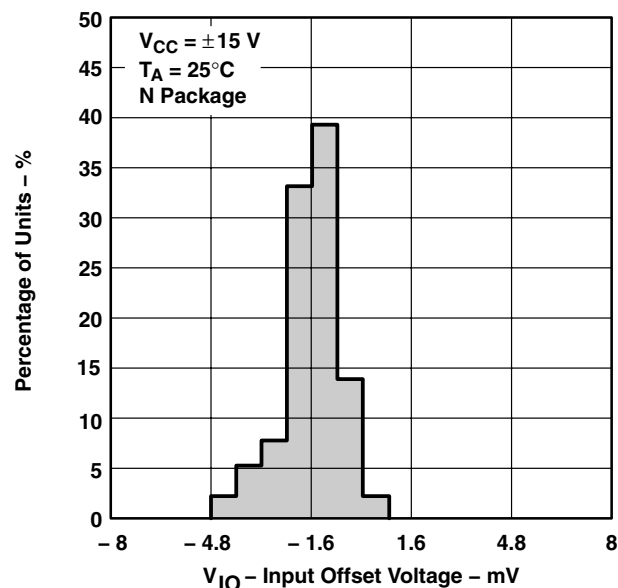


Figure 8

**DISTRIBUTION OF TLE2071 INPUT OFFSET
VOLTAGE TEMPERATURE COEFFICIENT**

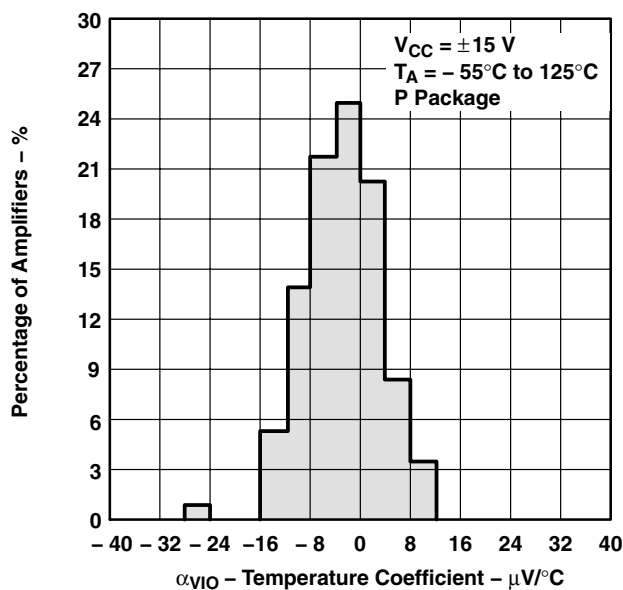


Figure 9

TYPICAL CHARACTERISTICS

**DISTRIBUTION OF TLE2072 INPUT OFFSET
VOLTAGE TEMPERATURE COEFFICIENT**

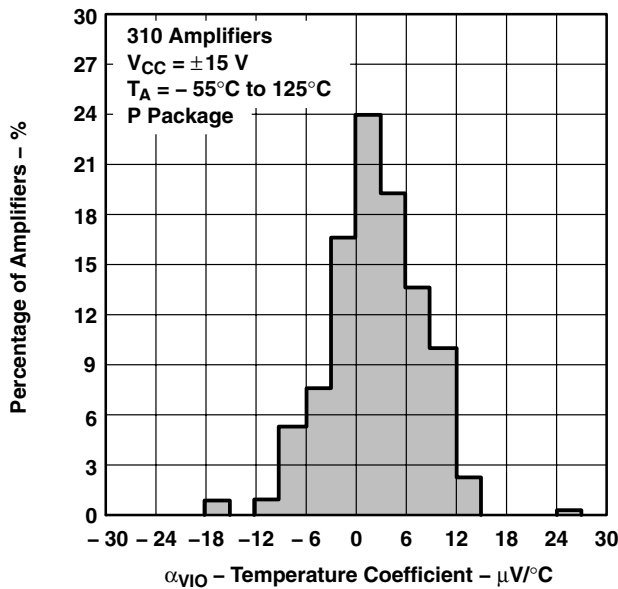


Figure 10

**DISTRIBUTION OF TLE2074 INPUT OFFSET
VOLTAGE TEMPERATURE COEFFICIENT**

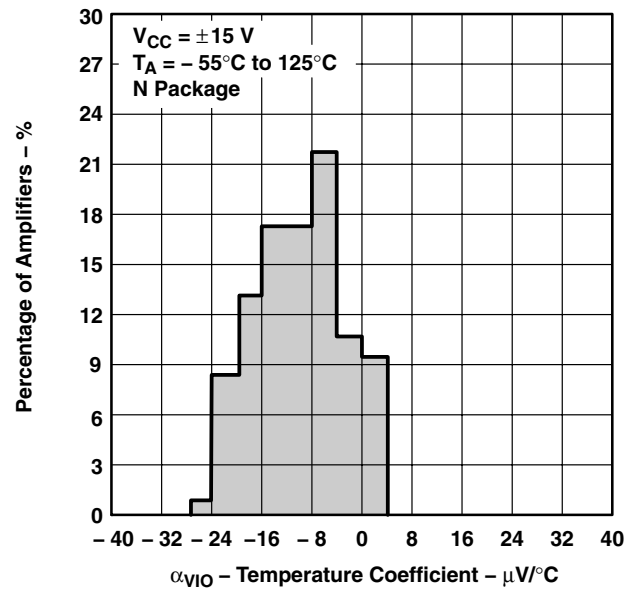


Figure 11

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

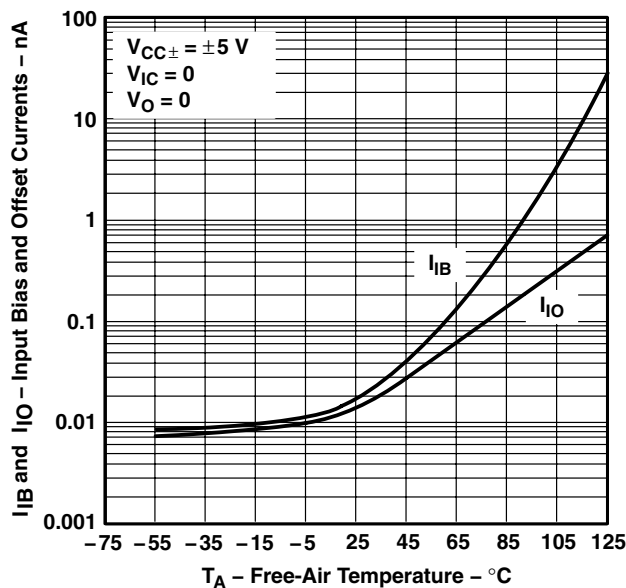


Figure 12

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

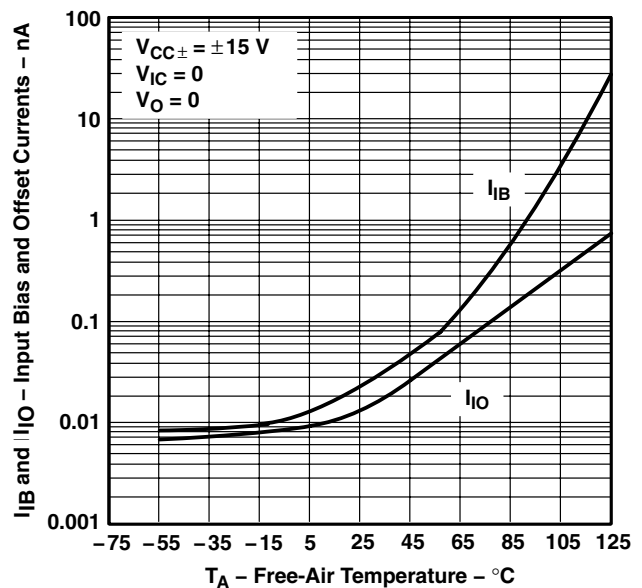


Figure 13

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

TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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TYPICAL CHARACTERISTICS

INPUT BIAS CURRENT
vs
TOTAL SUPPLY VOLTAGE

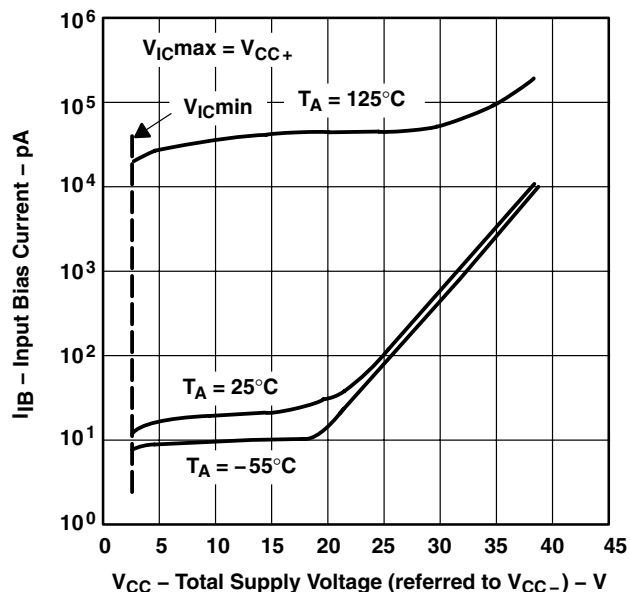


Figure 14

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

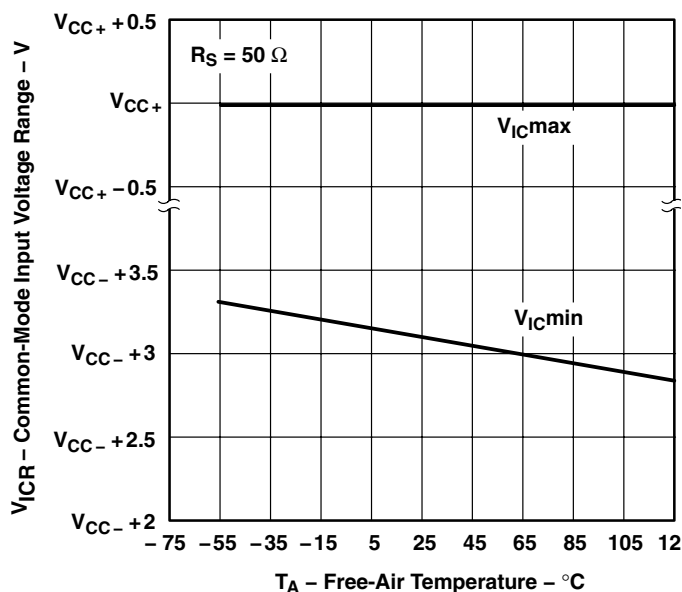


Figure 15

OUTPUT VOLTAGE
vs
DIFFERENTIAL INPUT VOLTAGE

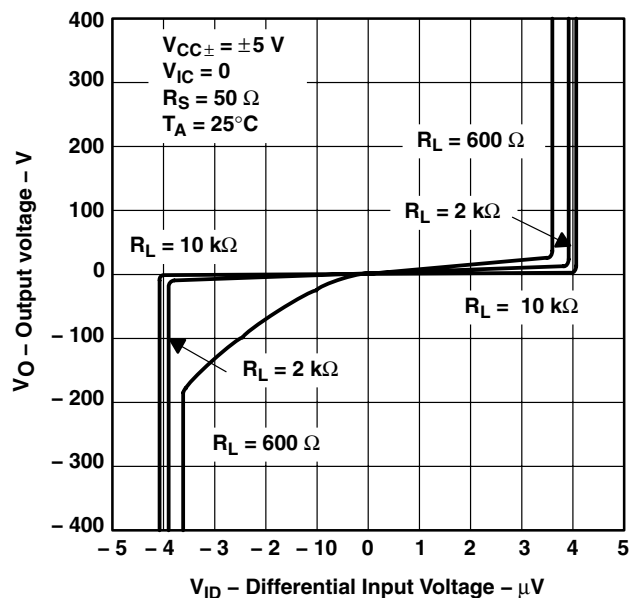


Figure 16

OUTPUT VOLTAGE
vs
DIFFERENTIAL INPUT VOLTAGE

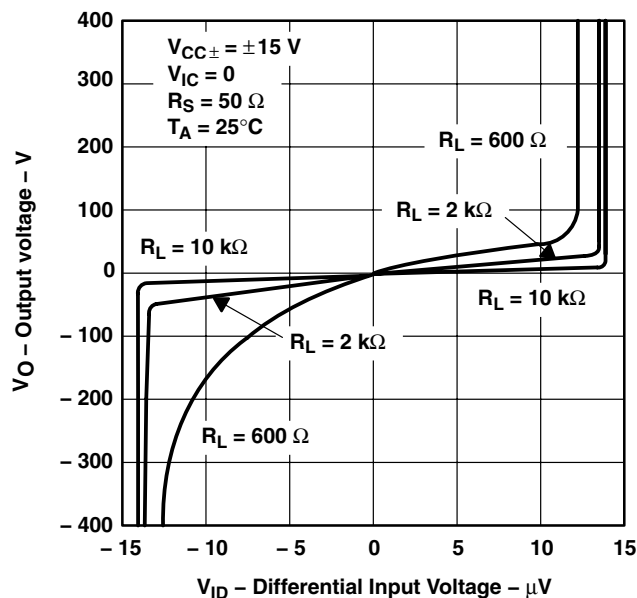
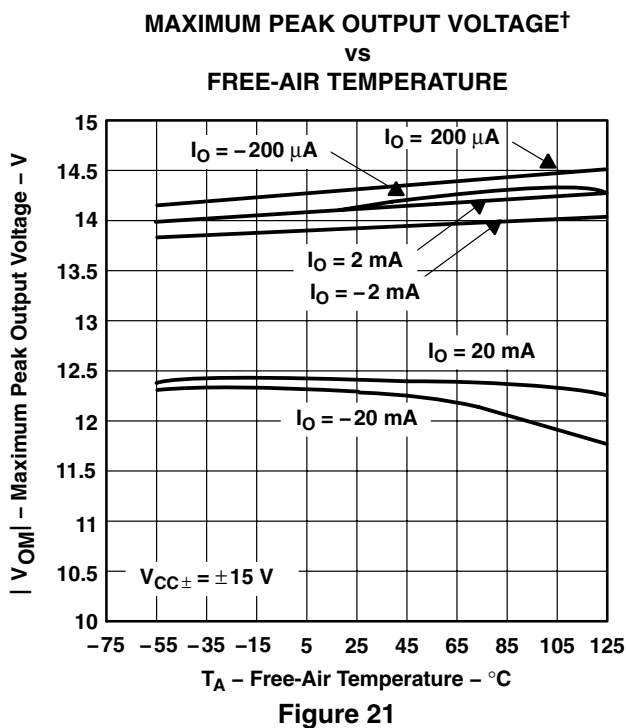
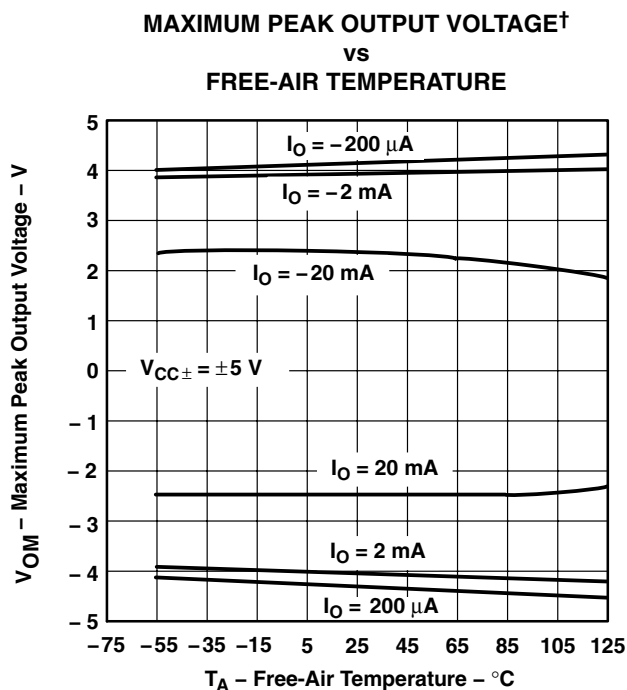
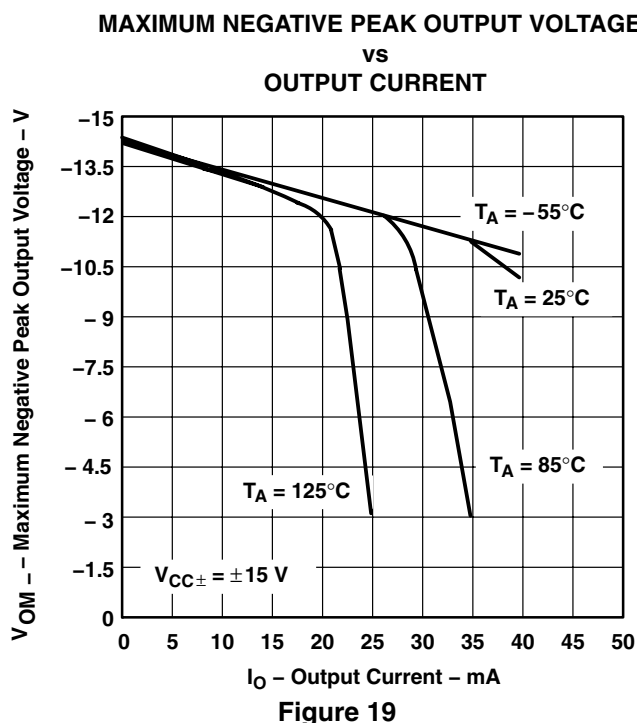
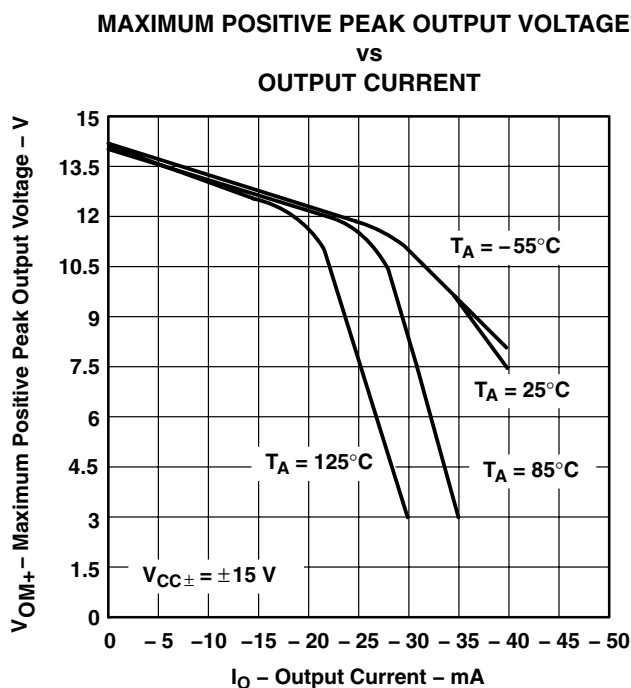


Figure 17

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

TYPICAL CHARACTERISTICS



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

TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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TYPICAL CHARACTERISTICS

MAXIMUM PEAK OUTPUT VOLTAGE
vs
SUPPLY VOLTAGE

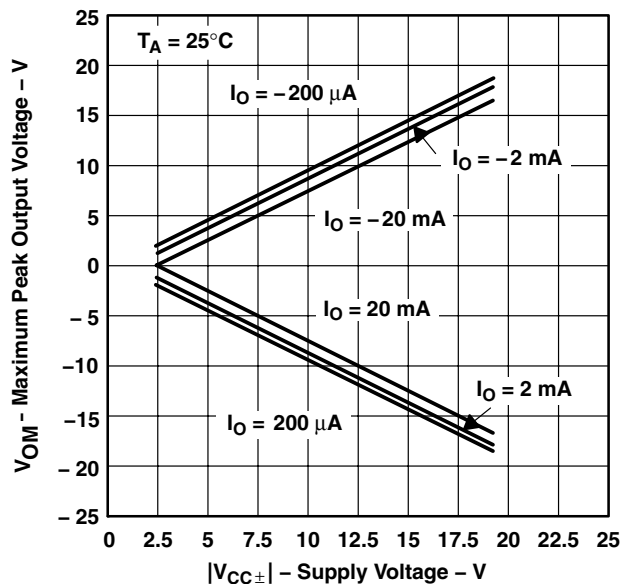


Figure 22

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE†
vs
FREQUENCY

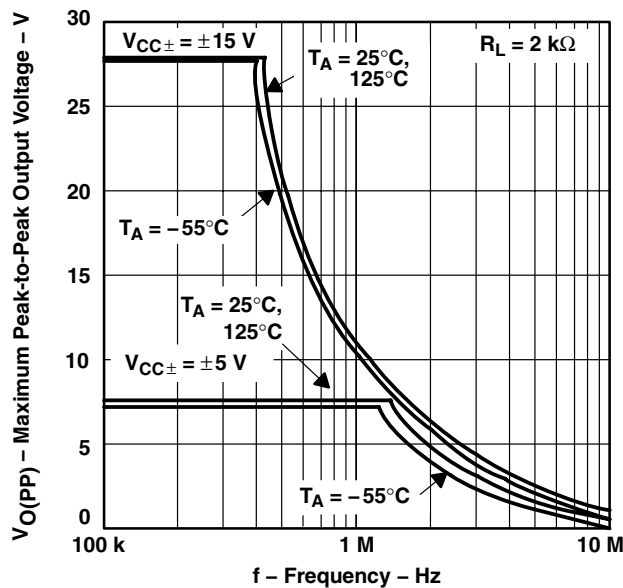


Figure 23

OUTPUT VOLTAGE
vs
SETTLING TIME

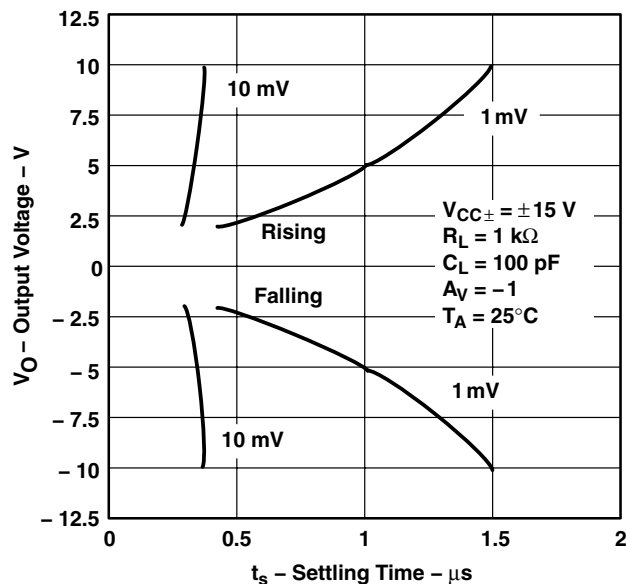


Figure 24

LARGE-SIGNAL DIFFERENTIAL
VOLTAGE AMPLIFICATION
vs
LOAD RESISTANCE

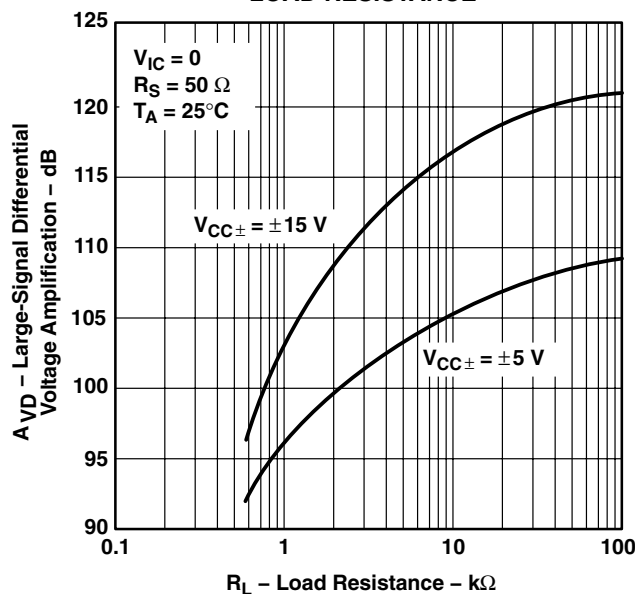


Figure 25

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

TYPICAL CHARACTERISTICS

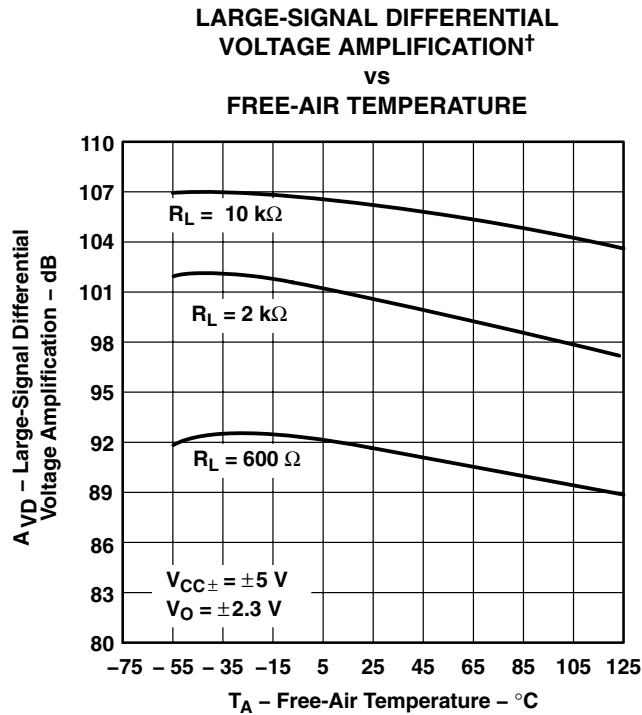


Figure 26

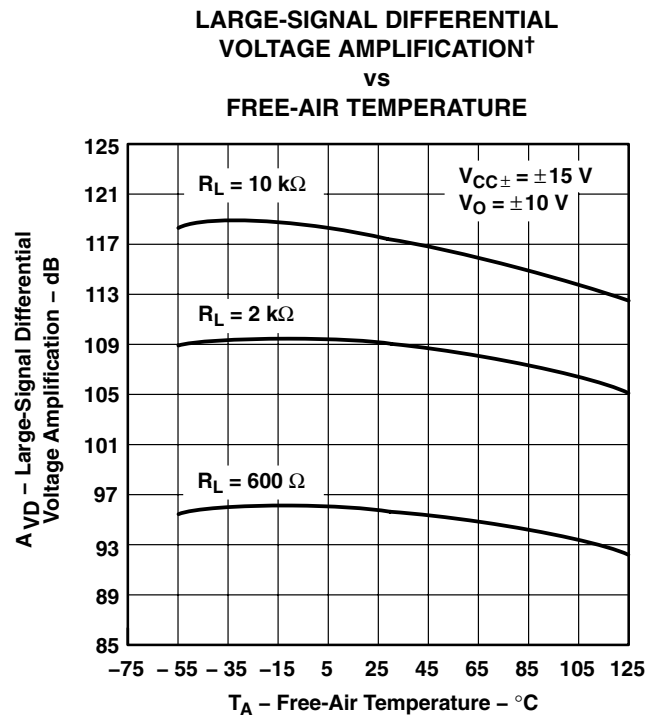


Figure 27

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

TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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TYPICAL CHARACTERISTICS

SMALL-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT

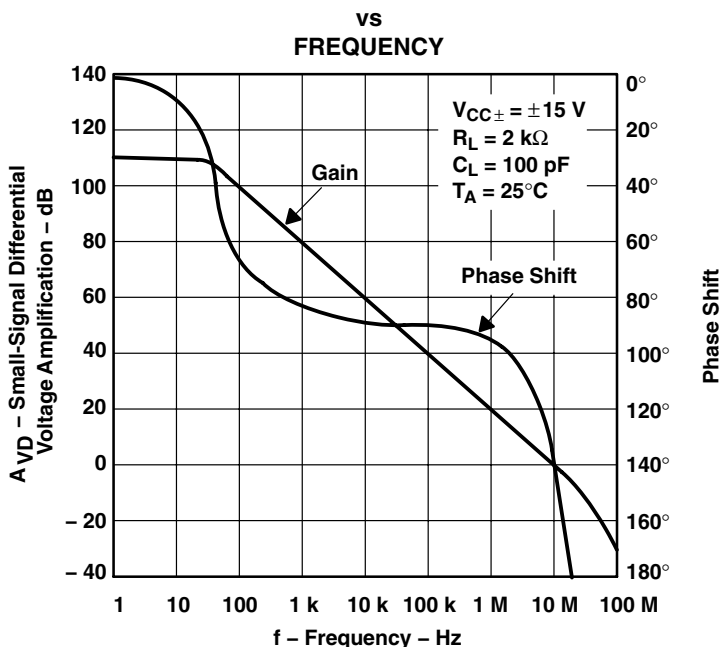


Figure 28

SMALL-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT

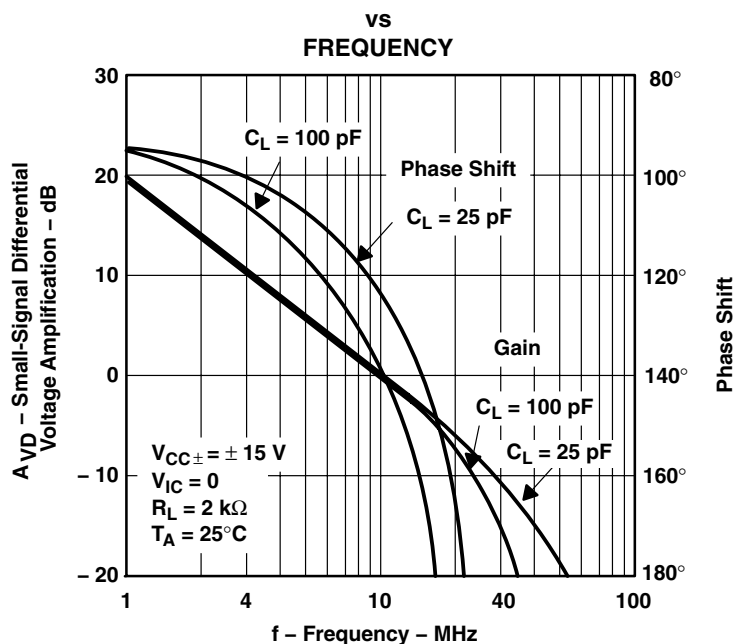
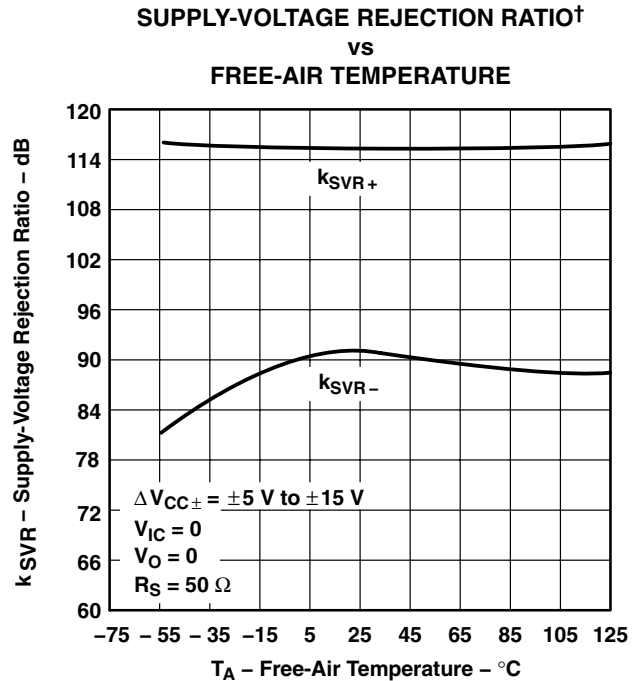
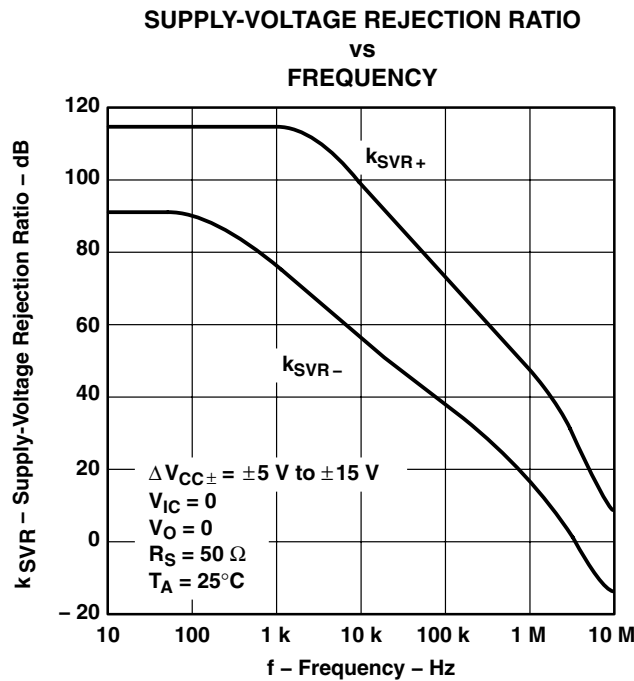
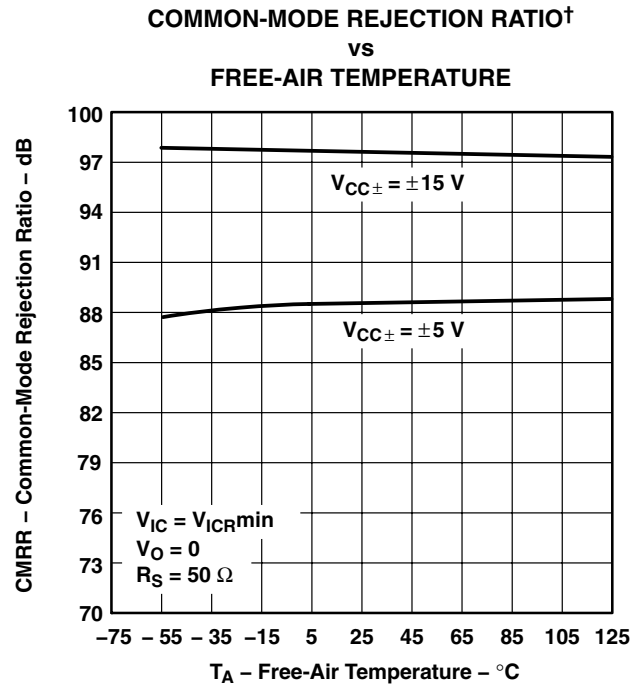
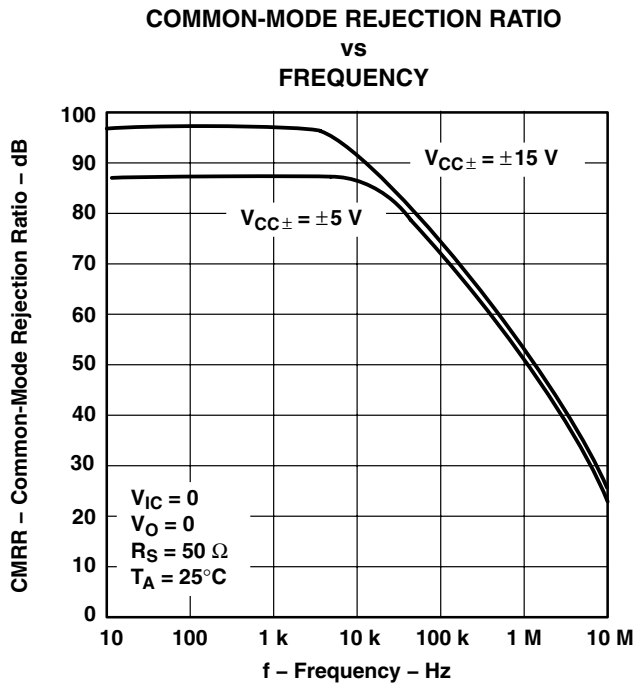


Figure 29

TYPICAL CHARACTERISTICS



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

TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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TYPICAL CHARACTERISTICS

**TLE2071
SUPPLY CURRENT
vs
SUPPLY VOLTAGE**

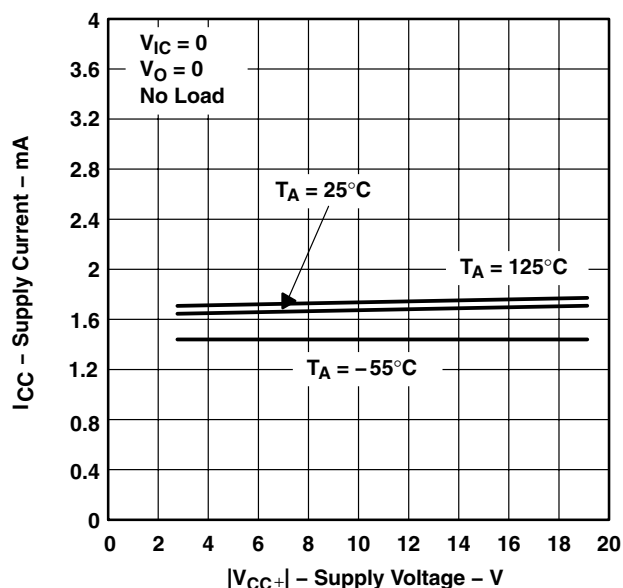


Figure 34

**TLE2072
SUPPLY CURRENT
vs
SUPPLY VOLTAGE**

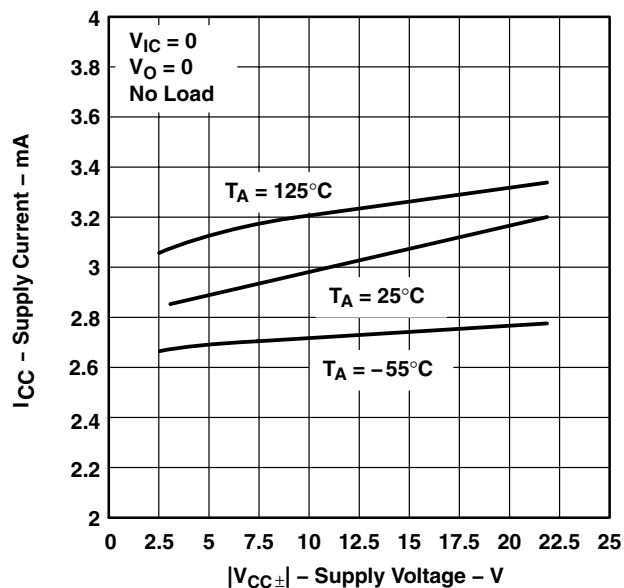


Figure 35

**TLE2074
SUPPLY CURRENT
vs
SUPPLY VOLTAGE**

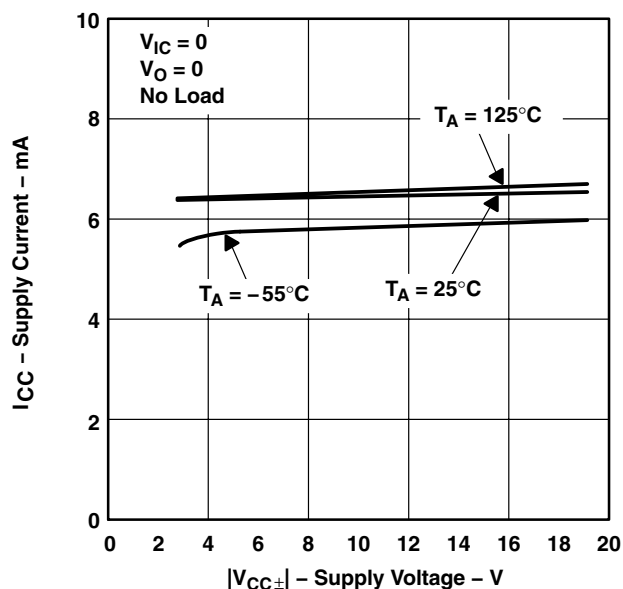


Figure 36

**TLE2071
SUPPLY CURRENT†
vs
FREE-AIR TEMPERATURE**

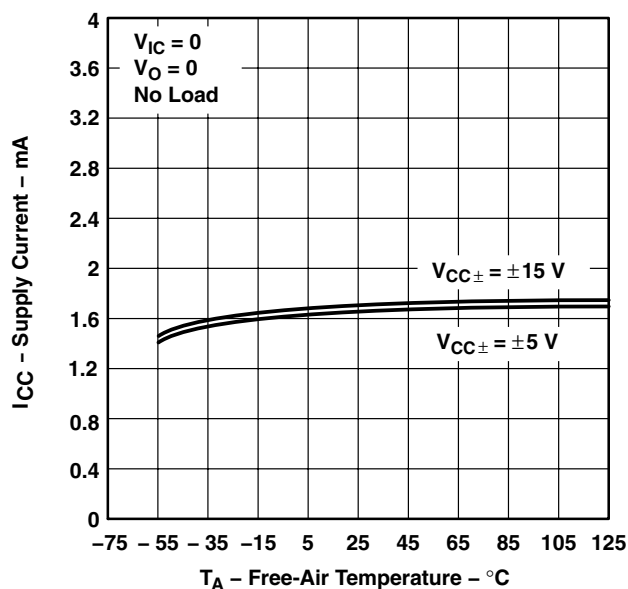


Figure 37

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

TYPICAL CHARACTERISTICS

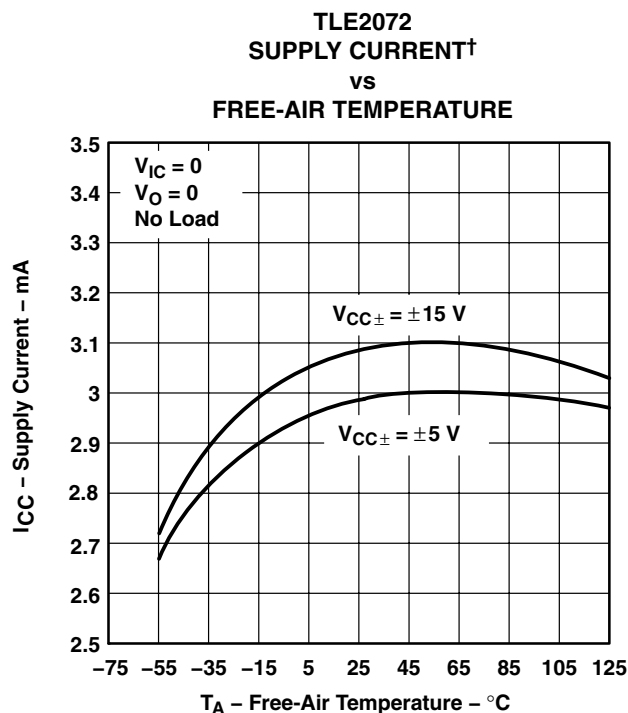


Figure 38

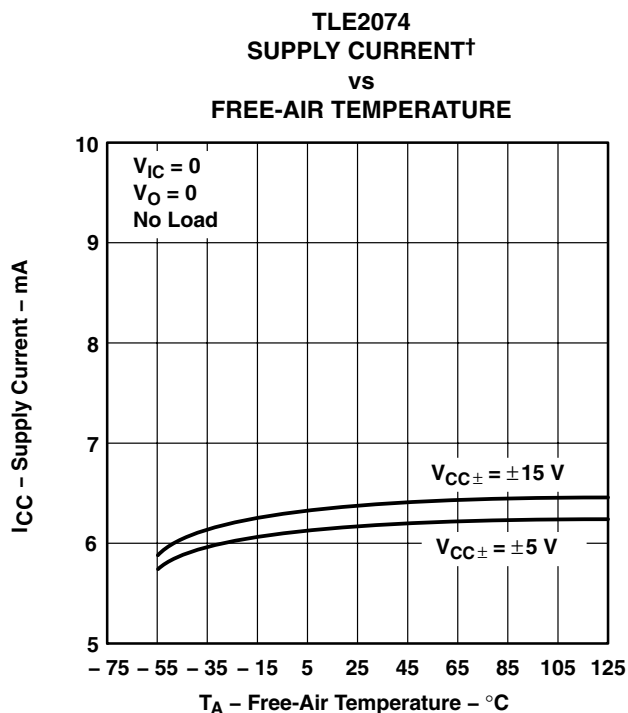


Figure 39

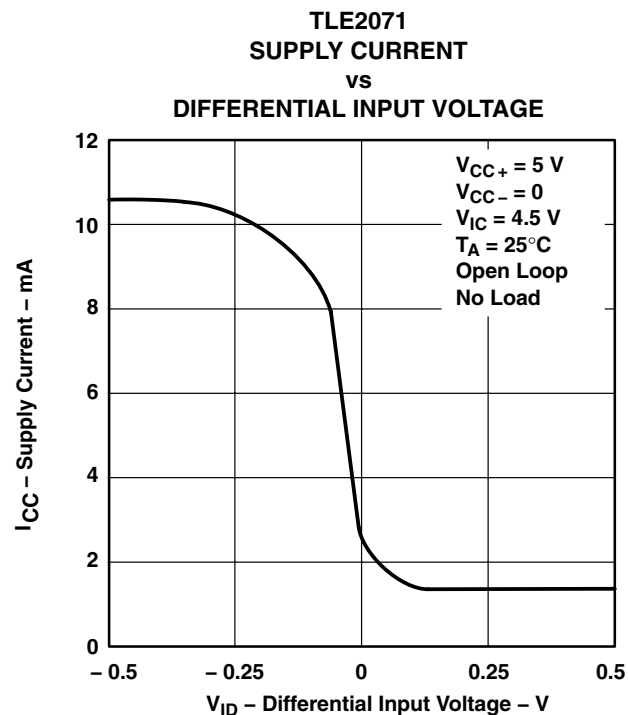


Figure 40

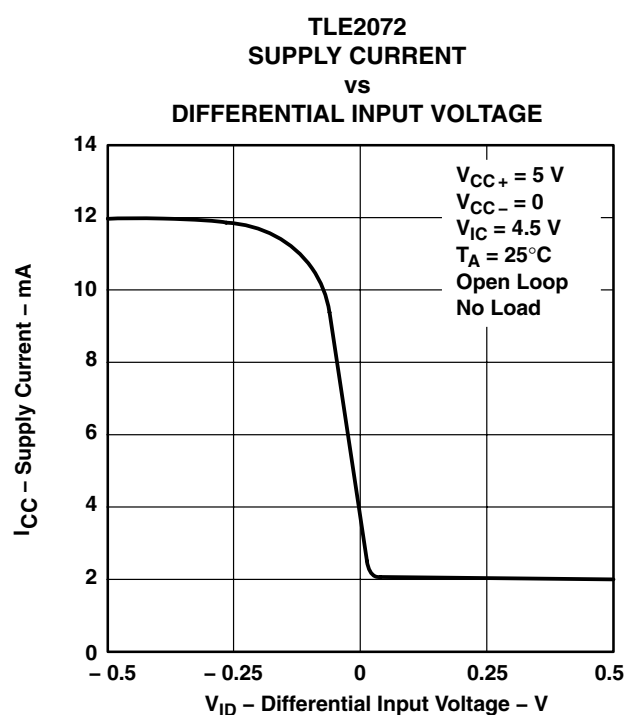


Figure 41

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

TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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TYPICAL CHARACTERISTICS

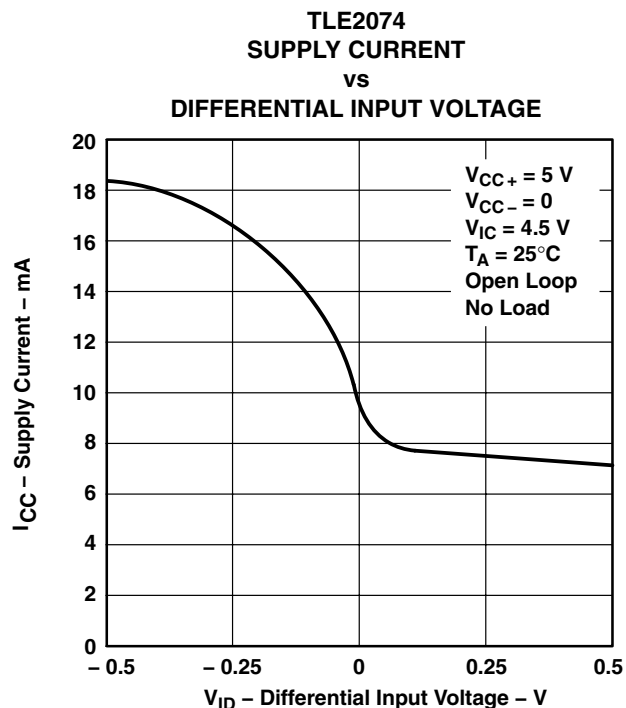


Figure 42

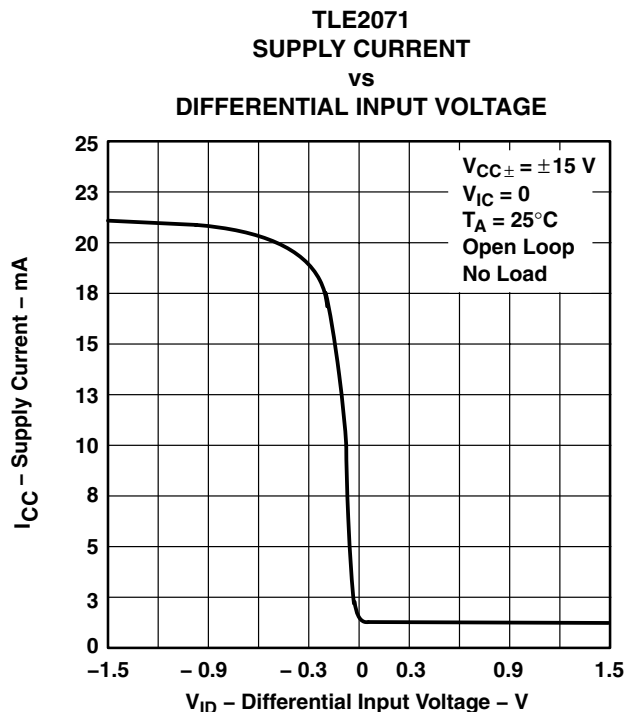


Figure 43

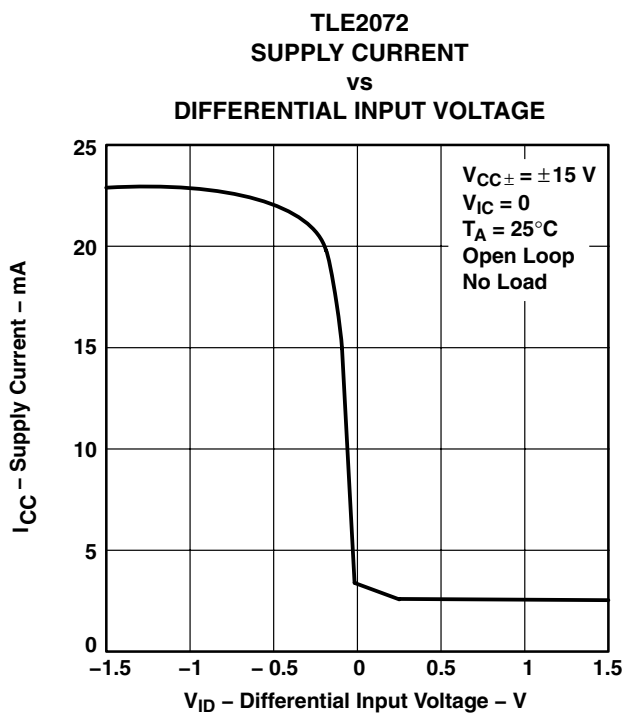


Figure 44

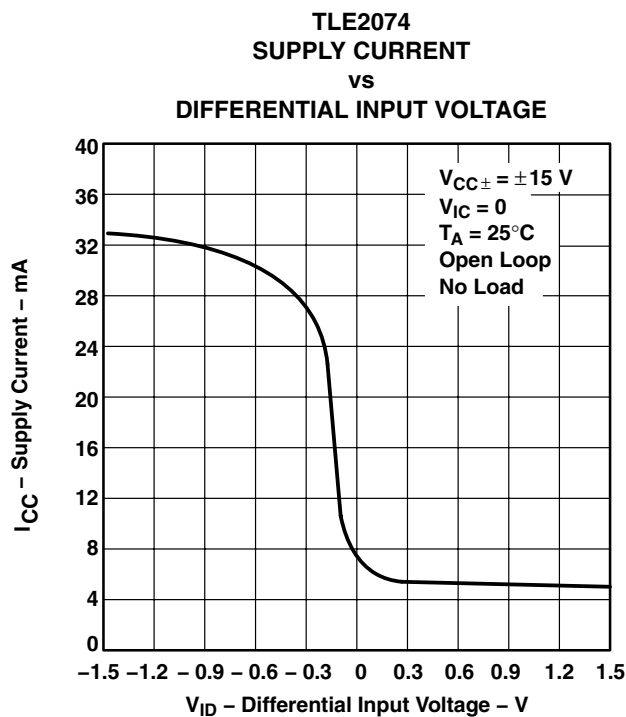
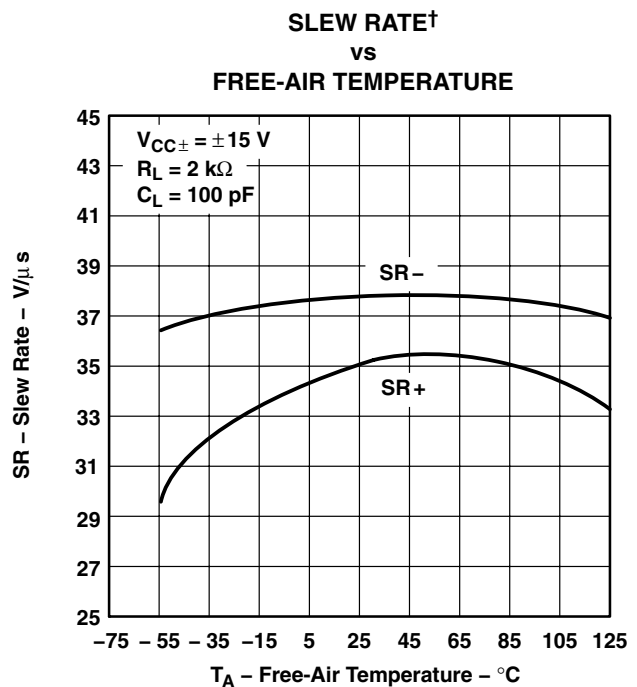
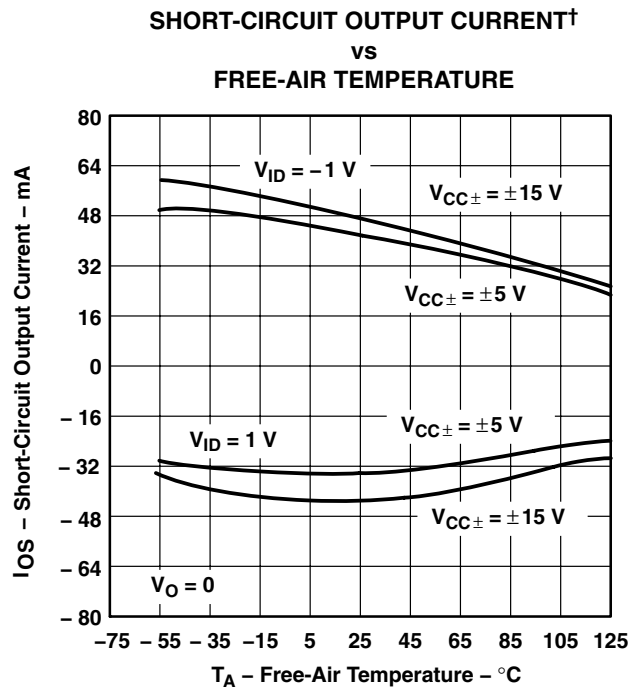
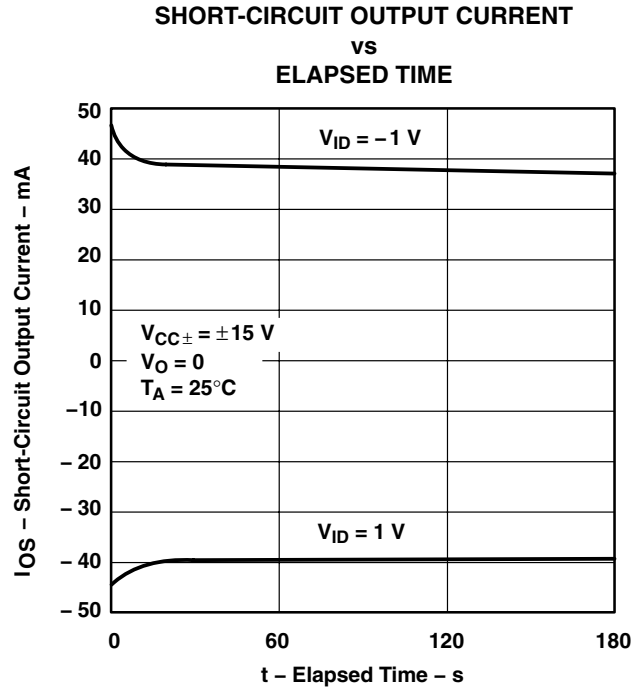
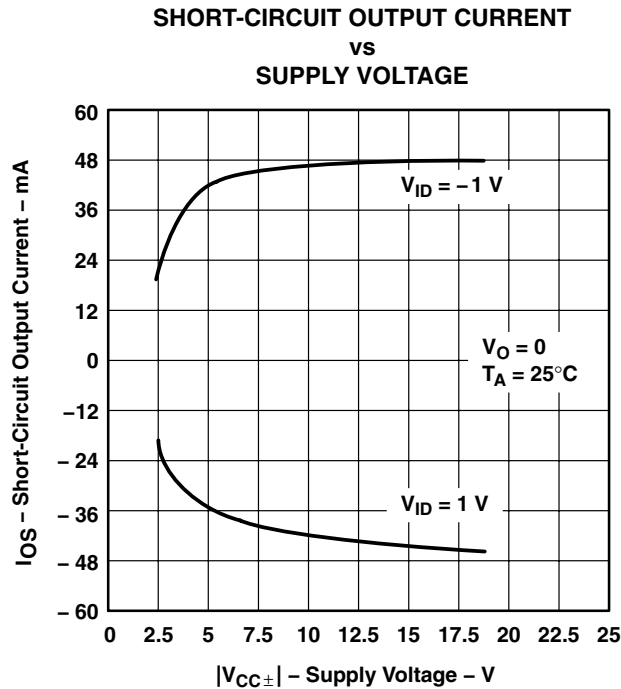


Figure 45

TYPICAL CHARACTERISTICS



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

TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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TYPICAL CHARACTERISTICS

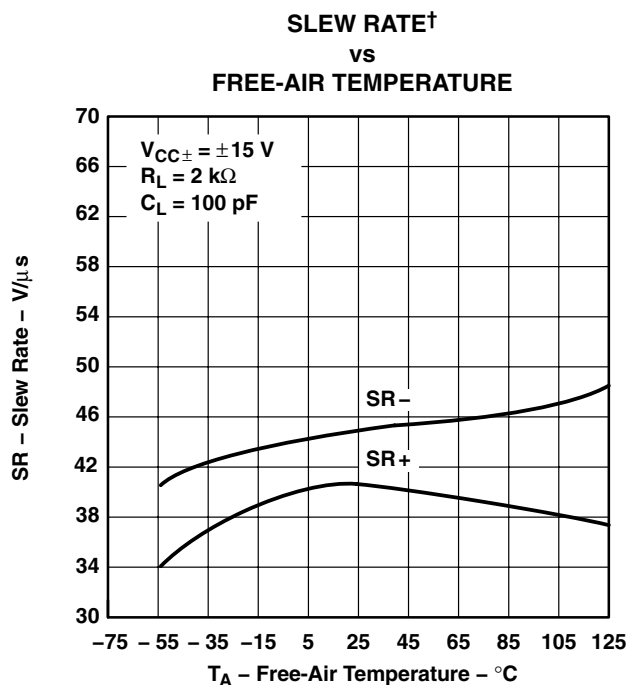


Figure 50

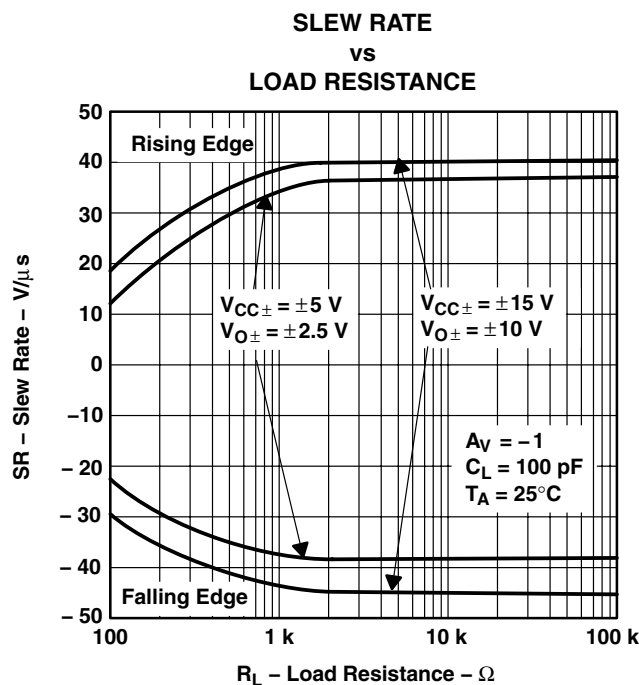


Figure 51

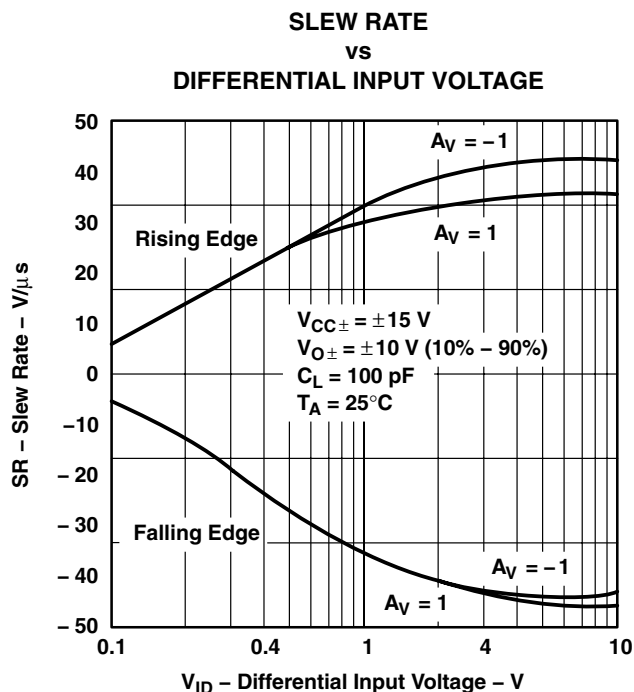


Figure 52

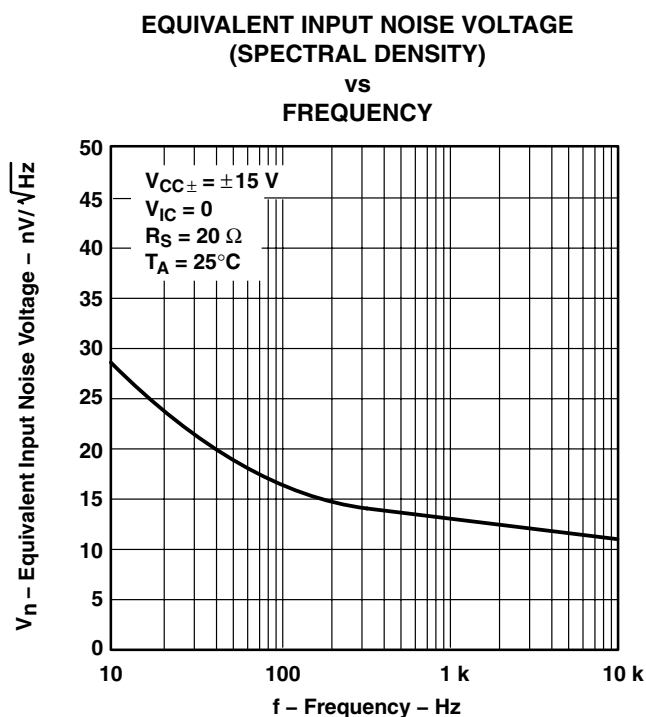
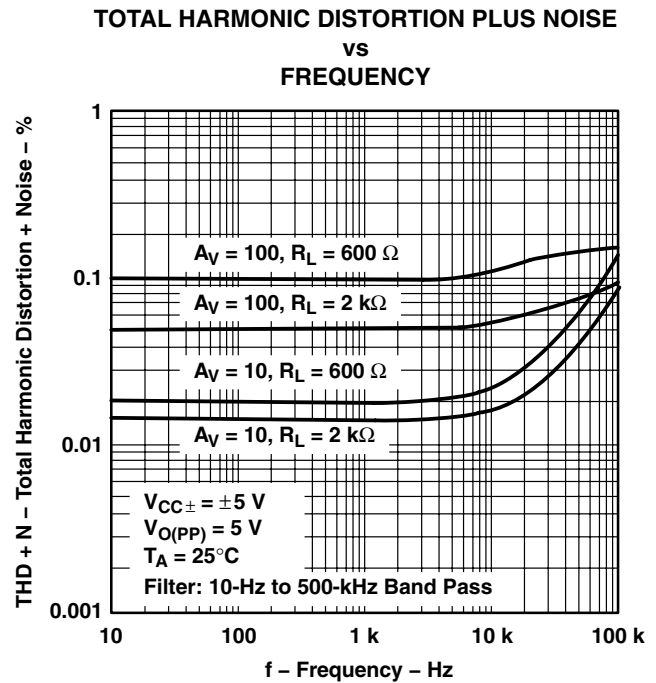
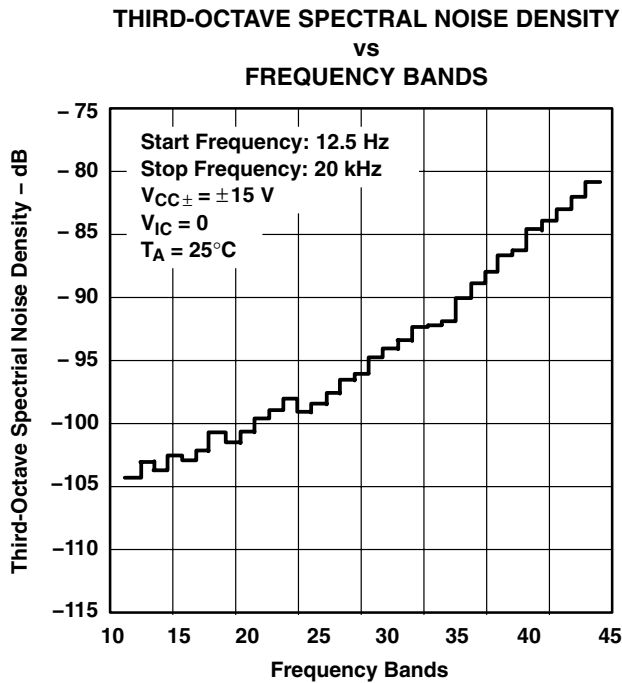
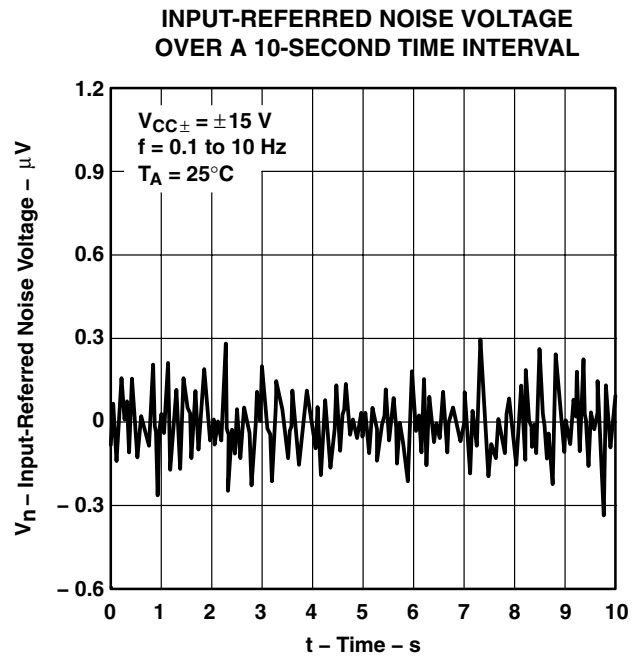
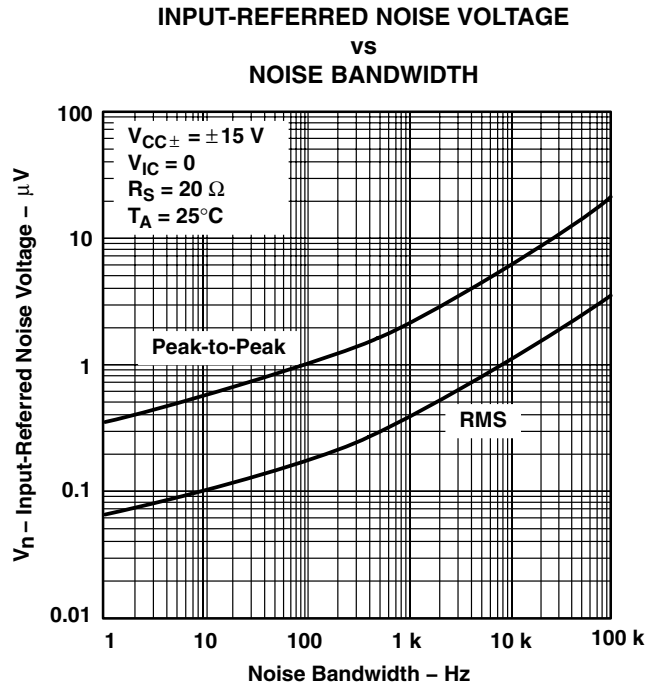


Figure 53

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

TYPICAL CHARACTERISTICS



TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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TYPICAL CHARACTERISTICS

**TOTAL HARMONIC DISTORTION PLUS NOISE
vs
FREQUENCY**

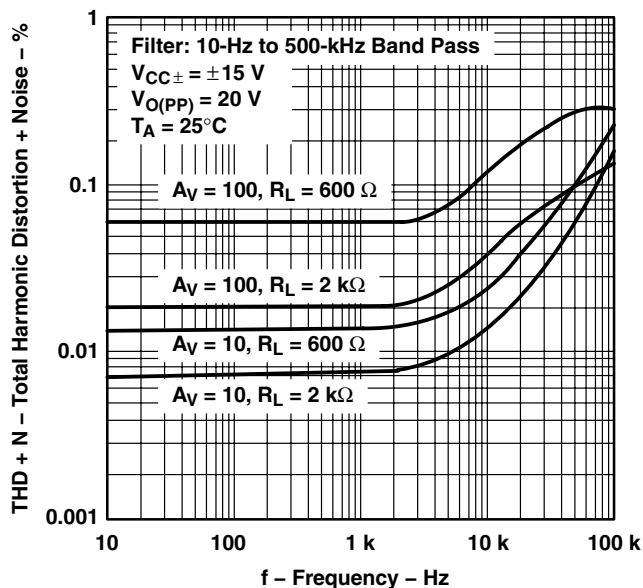


Figure 58

**UNITY-GAIN BANDWIDTH
vs
LOAD CAPACITANCE**

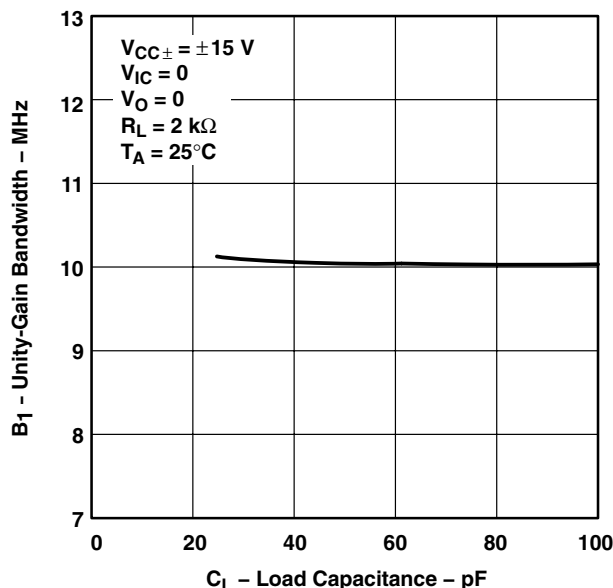


Figure 59

**GAIN-BANDWIDTH PRODUCT†
vs
FREE-AIR TEMPERATURE**

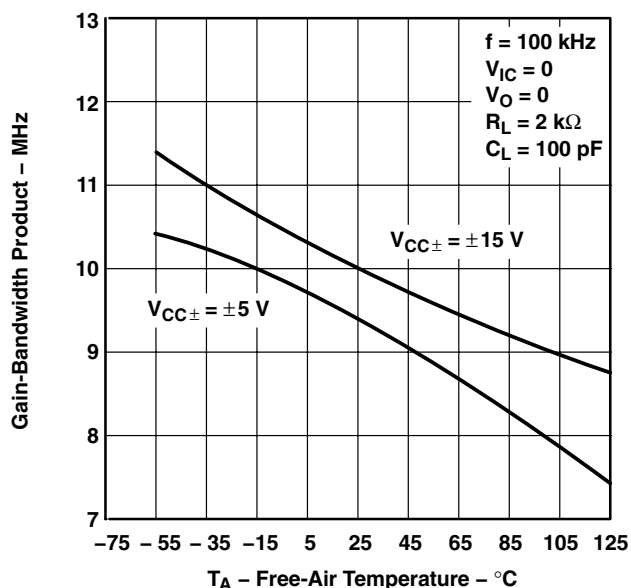


Figure 60

**GAIN-BANDWIDTH PRODUCT
vs
SUPPLY VOLTAGE**

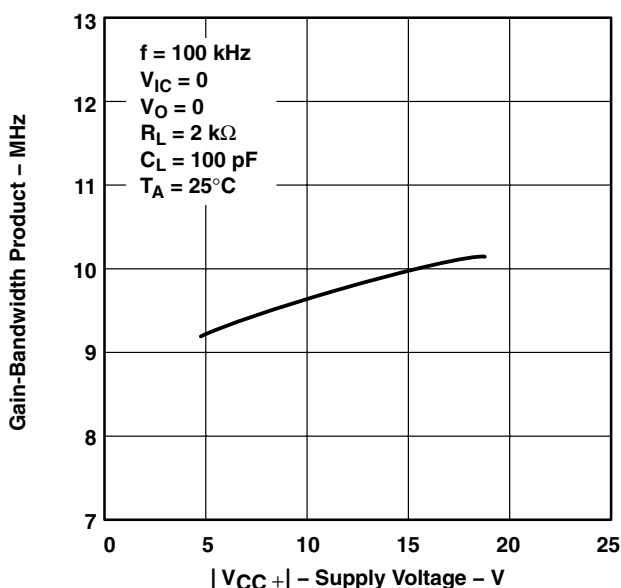


Figure 61

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

TYPICAL CHARACTERISTICS

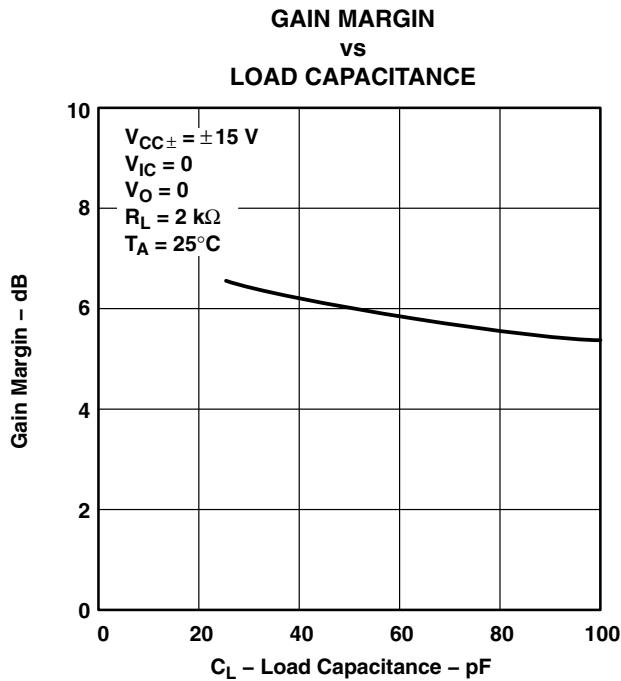


Figure 62

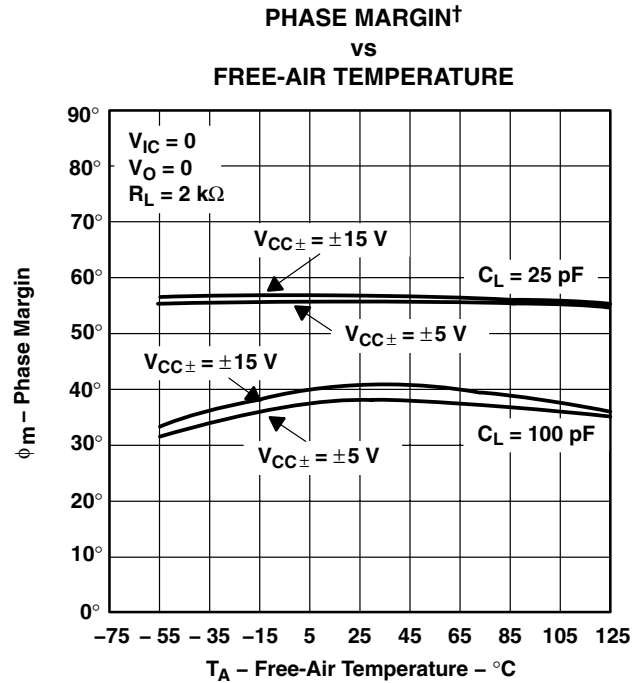


Figure 63

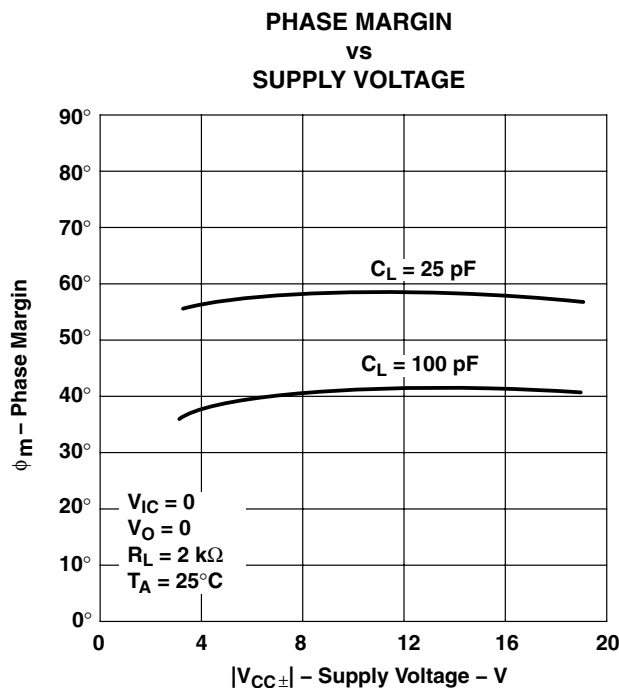


Figure 64

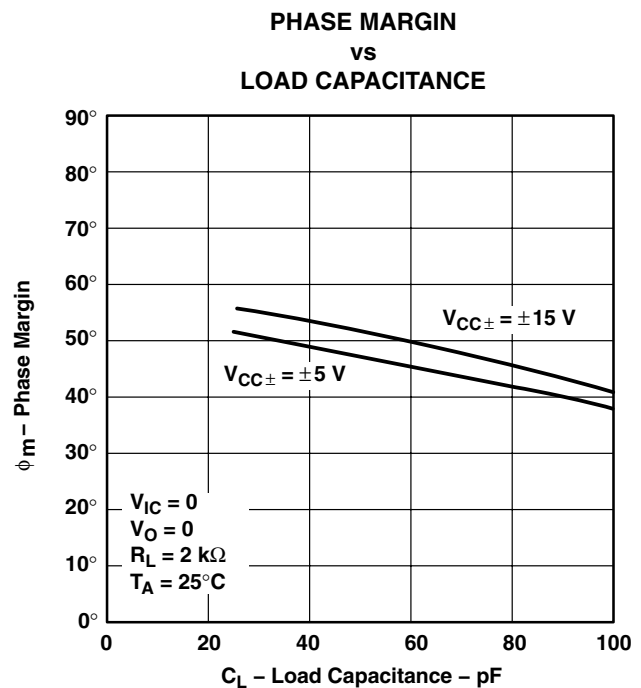


Figure 65

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

TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

TYPICAL CHARACTERISTICS

NONINVERTING LARGE-SIGNAL
PULSE RESPONSE†

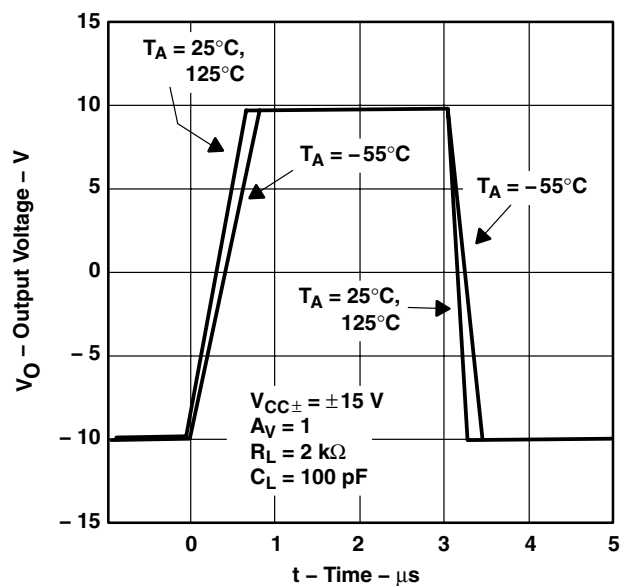


Figure 66

SMALL-SIGNAL PULSE RESPONSE

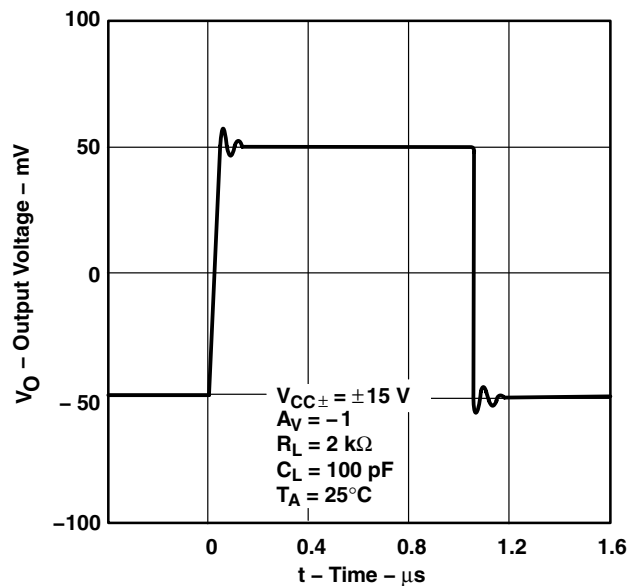


Figure 67

CLOSED-LOOP OUTPUT IMPEDANCE
vs
FREQUENCY

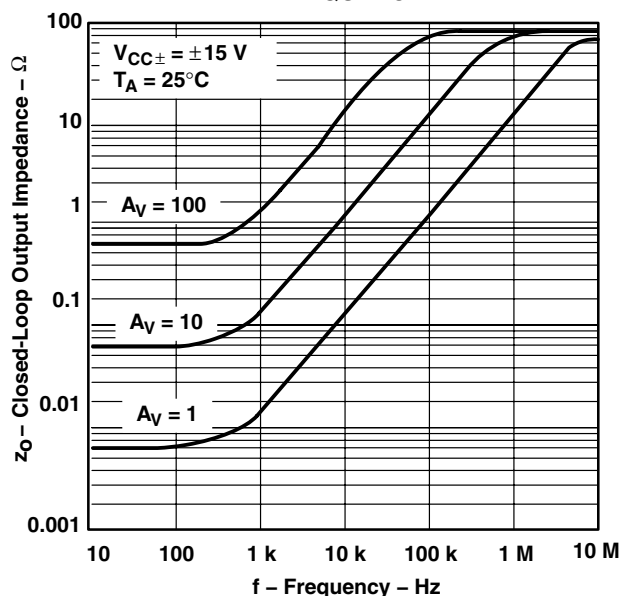


Figure 68

TLE2072 AND TLE2074
CROSSTALK ATTENUATION
vs
FREQUENCY

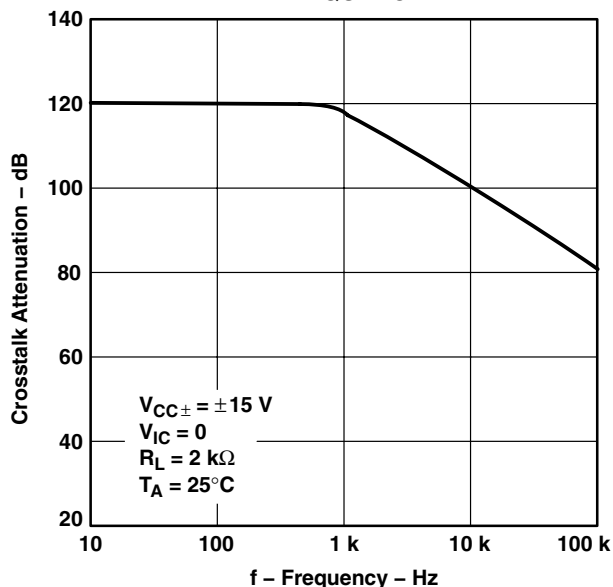


Figure 69

† 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.

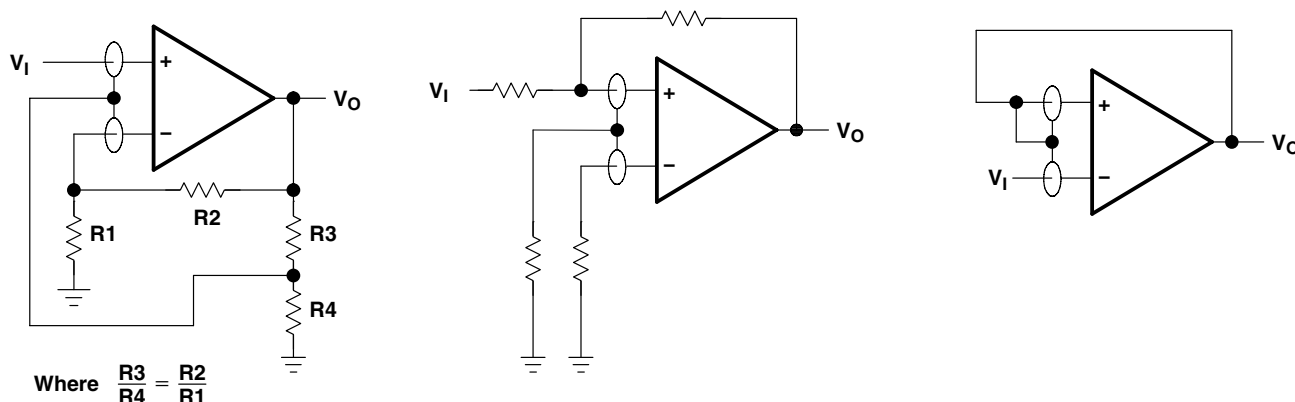


Figure 70. Use of Guard Rings

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.

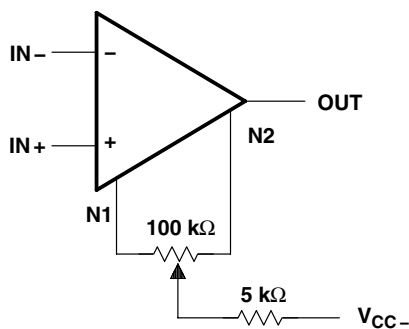


Figure 71. Input Offset Voltage Nulling

TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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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 $T_A = 25^\circ\text{C}$. Using this information, output simulations of the following key parameters can be generated to a tolerance of 20% (in most cases):

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

NOTE 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).

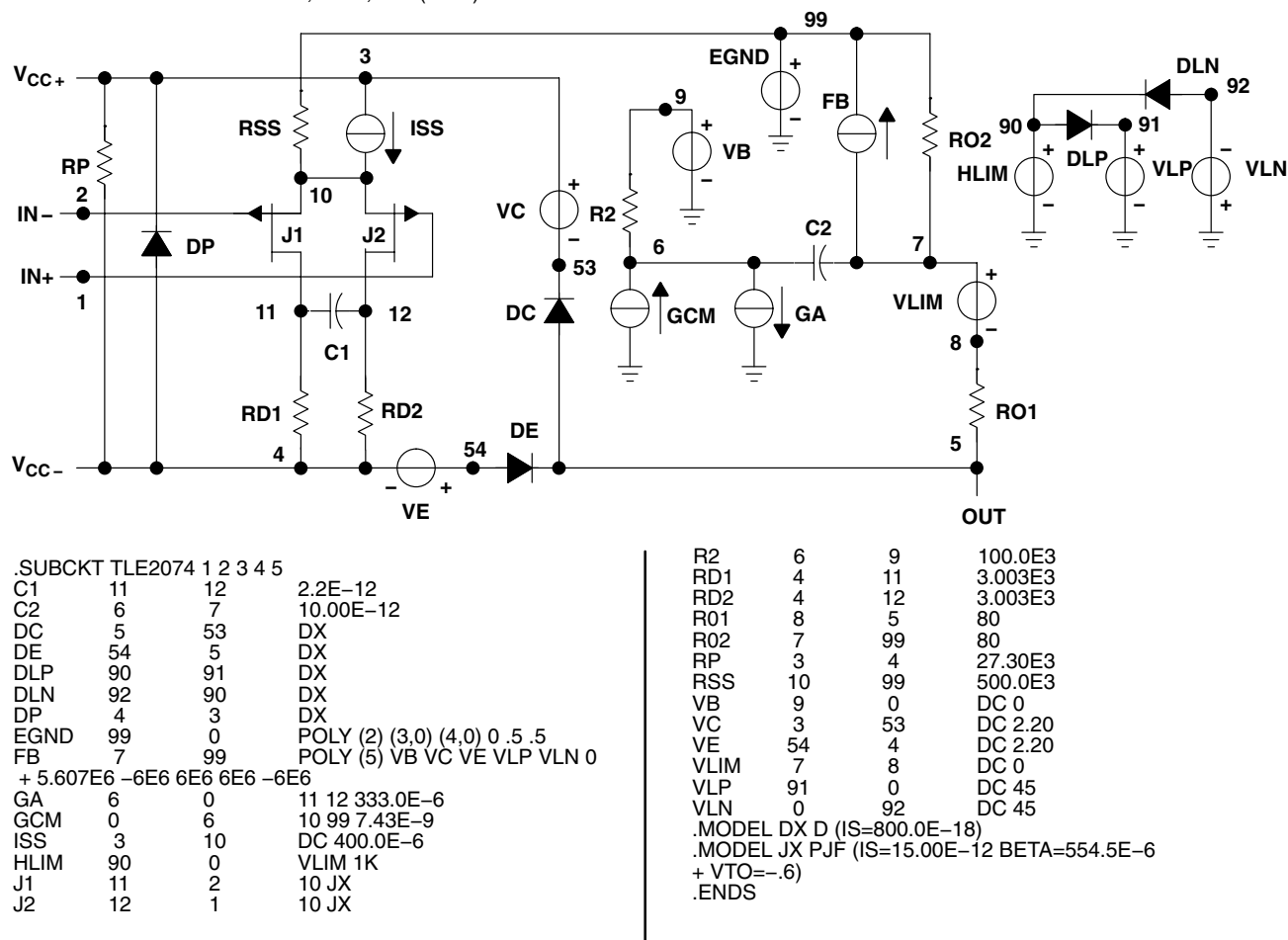


Figure 72. Boyle Macromodel and Subcircuit

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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)	Op Temp (°C)	Device Marking (4/5)	Samples
TLE2071AQDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	2071AQ	Samples
TLE2071AQDRQ1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	2071AQ	Samples
TLE2071QDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	2071Q1	Samples
TLE2071QDRQ1	OBSOLETE	SOIC	D	8		TBD	Call TI	Call TI	-40 to 125	2071Q1	
TLE2072AQDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	2072AQ	Samples
TLE2072AQDRQ1	ACTIVE	SOIC	D	8		TBD	Call TI	Call TI	-40 to 125	2072AQ	Samples
TLE2072QDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	2072Q1	Samples
TLE2072QDRQ1	ACTIVE	SOIC	D	8		TBD	Call TI	Call TI	-40 to 125	2072Q1	Samples

(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.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

⁽⁵⁾ Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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

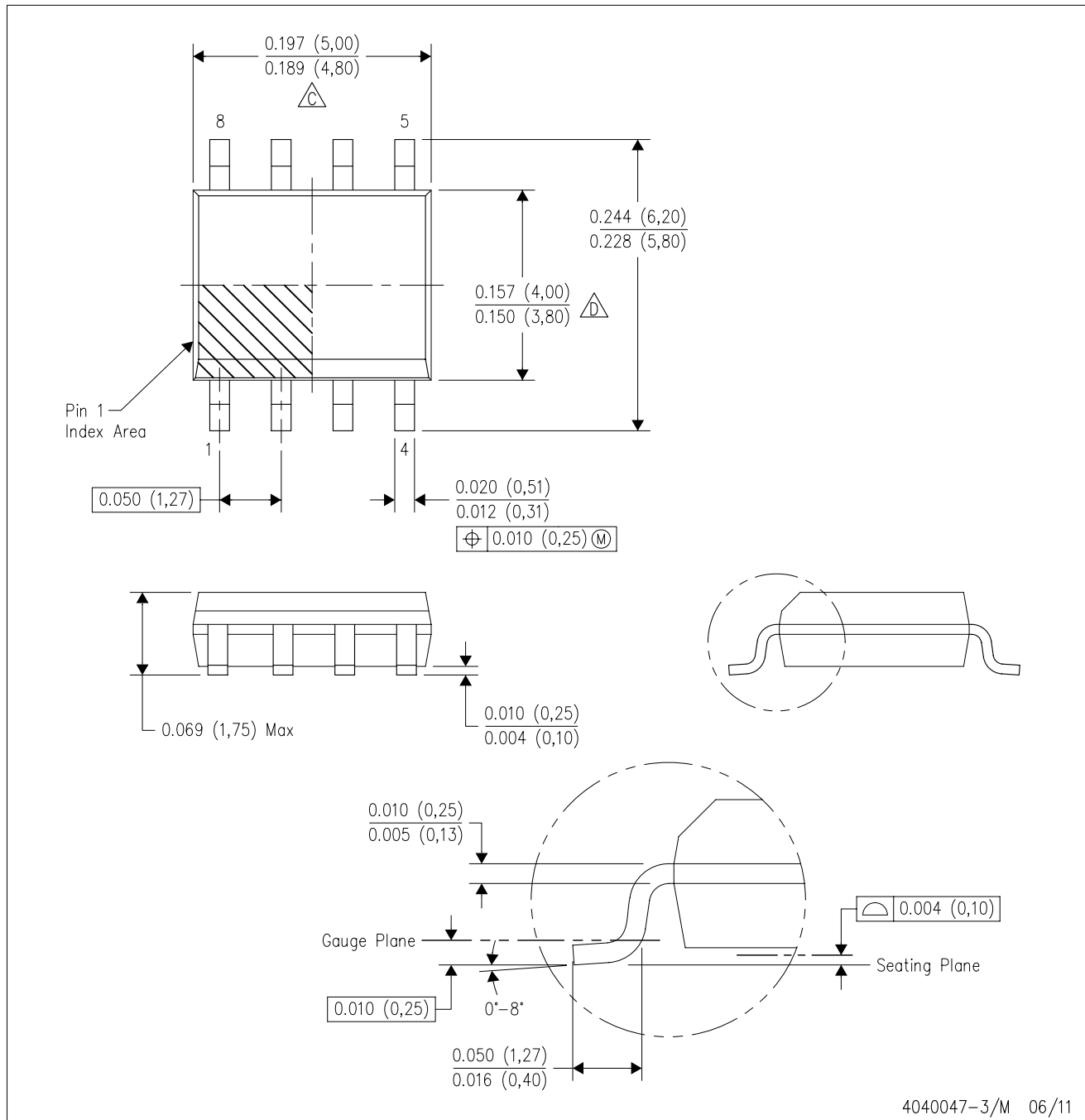
- Catalog: [TLE2071](#), [TLE2071A](#), [TLE2072](#), [TLE2072A](#)
- Military: [TLE2071M](#), [TLE2071AM](#), [TLE2072M](#), [TLE2072AM](#)

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.
 - $\triangle C$ 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.
 - $\triangle D$ 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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