



THE DATASHEET OF TLE2072QDRQ1

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



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2008, Texas Instruments Incorporated

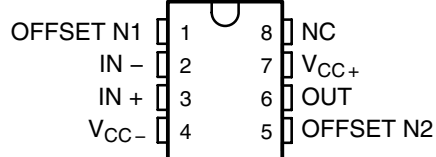
TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

SGLS226B – DECEMBER 2003 – REVISED MAY 2008

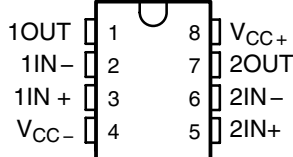
description/ordering information (continued)

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.

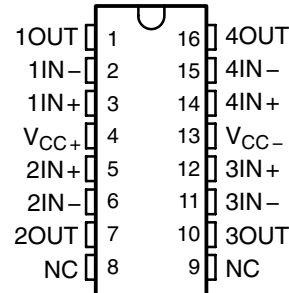
TLE2071 AND TLE2071A
D PACKAGE
(TOP VIEW)



TLE2072 AND TLE2072A
D PACKAGE
(TOP VIEW)

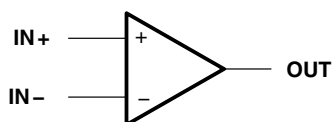


TLE2074 AND TLE2074A
DW PACKAGE
(TOP VIEW)



NC – No internal connection

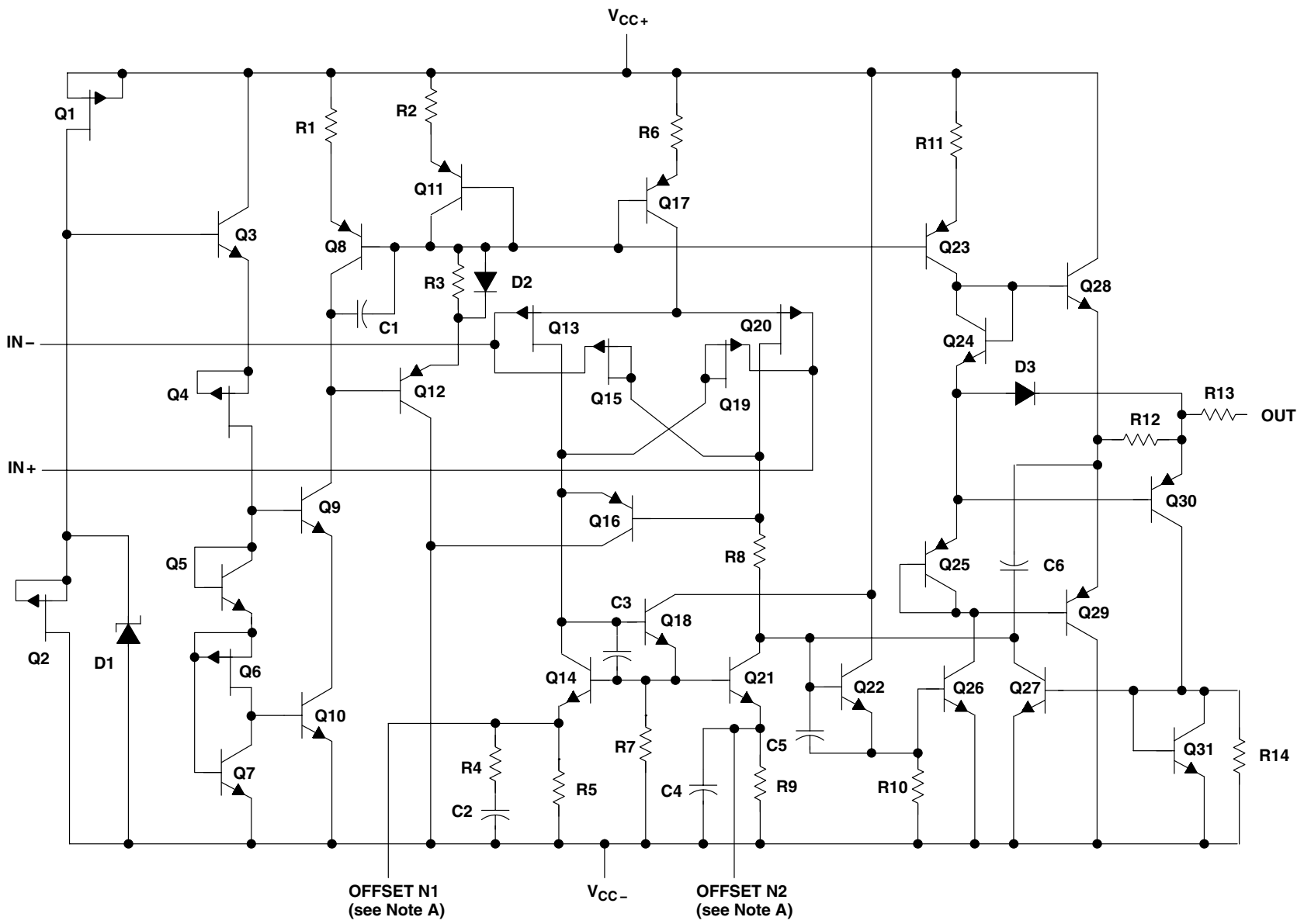
symbol



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

SLOS181A – FEBRUARY 1997 – REVISED MARCH 2000 (sourced from

equivalent schematic



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

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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

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

TLE207x-Q1, TLE207xA-Q1

EXCALIBUR LOW-NOISE HIGH-SPEED

JFET-INPUT OPERATIONAL AMPLIFIERS

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

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 $125^\circ C$.



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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

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.

TLE207x-Q1, TLE207xA-Q1

EXCALIBUR LOW-NOISE HIGH-SPEED

JFET-INPUT OPERATIONAL AMPLIFIERS

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

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 $125^\circ C$.



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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

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, 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.



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)

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			
	$I_O = -2$ 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	$I_O = 200 \mu A$	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	$V_O = \pm 2.3$ V	$R_L = 600 \Omega$	25°C	80	91	80	91		dB
			Full range	78		78			
		$R_L = 2$ k Ω	25°C	90	100	90	100		
			Full range	88		88			
		$R_L = 10$ k Ω	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	$V_{IC} = V_{ICRmin},$ $V_O = 0, R_S = 50 \Omega$	25°C	70	89		70	89		dB
		Full range	68			68			

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



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

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.



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, $V_{CC\pm} = \pm 15$ 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 $-40^\circ C$ to $125^\circ C$.



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, $V_{CC\pm} = \pm 15$ 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 .

TLE207x-Q1, TLE207xA-Q1

EXCALIBUR LOW-NOISE HIGH-SPEED

JFET-INPUT OPERATIONAL AMPLIFIERS

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

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 $125^\circ C$.

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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

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.

TLE207x-Q1, TLE207xA-Q1

EXCALIBUR LOW-NOISE HIGH-SPEED

JFET-INPUT OPERATIONAL AMPLIFIERS

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

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 $125^\circ C$.

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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

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

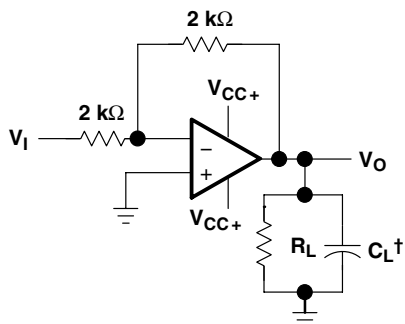
PARAMETER		TEST CONDITIONS		T _A [†]	TLE2074-Q1			TLE2074A-Q1			UNIT		
					MIN	TYP	MAX	MIN	TYP	MAX			
SR +	Positive slew rate	V _{O(PP)} = 10 V, A _{VD} = −1, R _L = 2 kΩ, C _L = 100 pF, See Figure 1		25°C	25	40		25	40		V/μs		
				Full range	17			17					
SR −	Negative slew rate			25°C	30	45		30	45	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

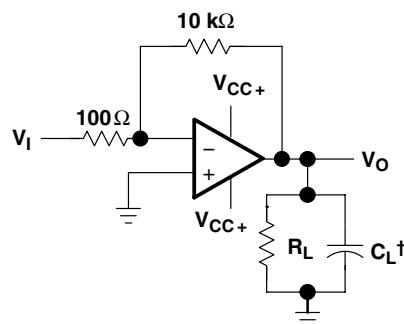
SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

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

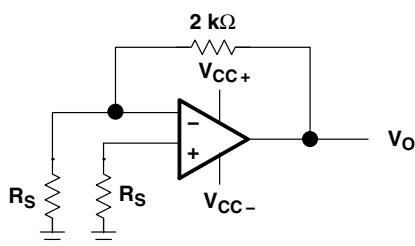


Figure 3. Noise-Voltage Test Circuit

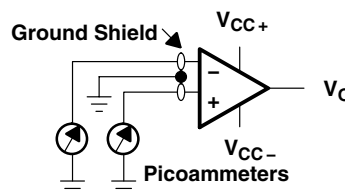


Figure 4. Input-Bias and Offset-Current Test Circuit

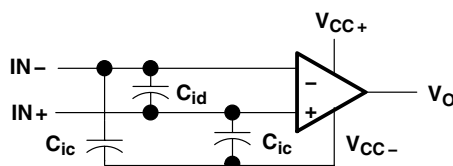


Figure 5. Internal Input Capacitance

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
V_n	Input referred noise voltage	vs Noise bandwidth Over a 10-second time interval	54 55
	Third-octave spectral noise density	vs Frequency bands	56
$THD + N$	Total harmonic distortion plus noise	vs Frequency	57, 58
B_1	Unity-gain bandwidth	vs Load capacitance	59
	Gain-bandwidth product	vs Free-air temperature vs Supply voltage	60 61
	Gain margin	vs Load capacitance	62
ϕ_m	Phase margin	vs Free-air temperature vs Supply voltage vs Load capacitance	63 64 65
	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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

TYPICAL CHARACTERISTICS

**DISTRIBUTION OF TLE2071
INPUT OFFSET VOLTAGE**

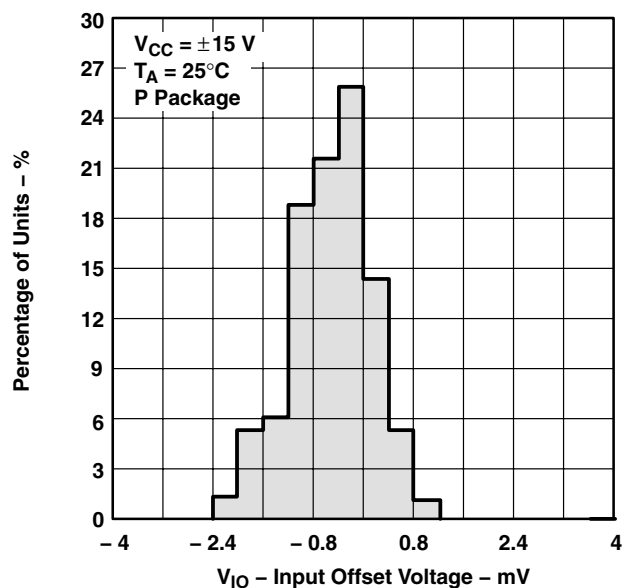


Figure 6

**DISTRIBUTION OF TLE2072
INPUT OFFSET VOLTAGE**

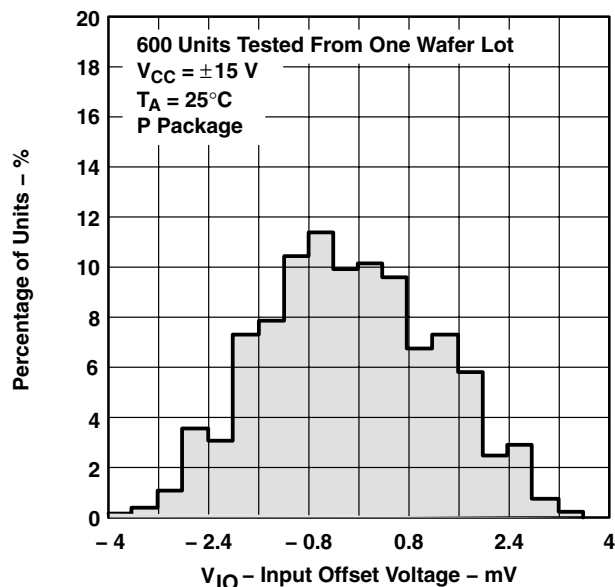


Figure 7

**DISTRIBUTION OF TLE2074
INPUT OFFSET VOLTAGE**

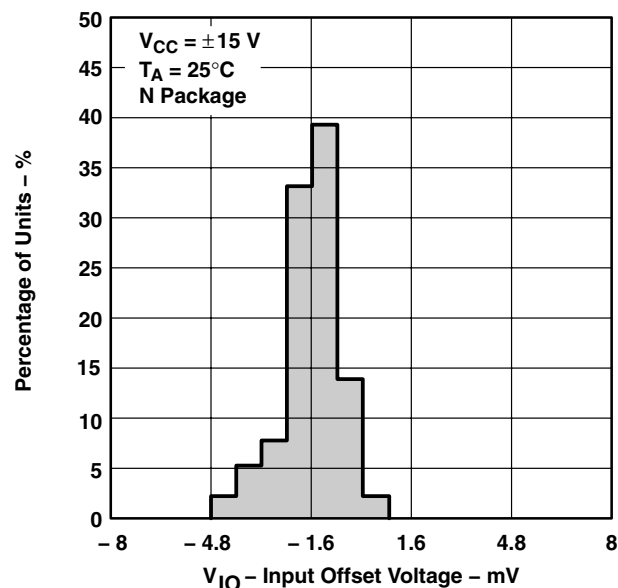


Figure 8

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

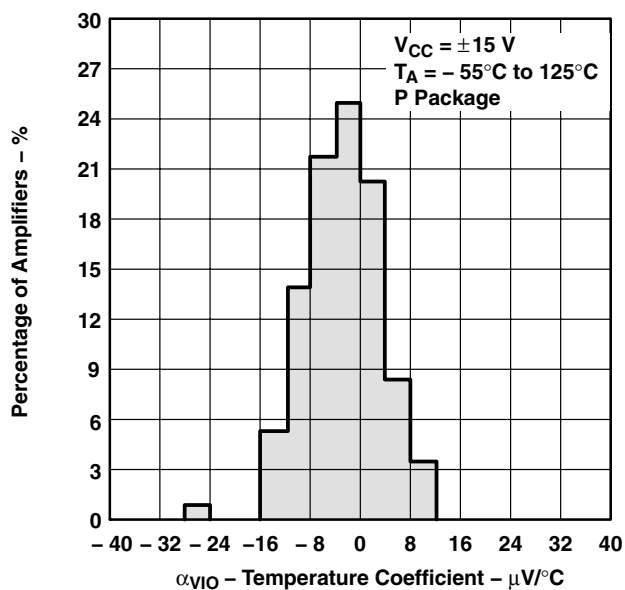


Figure 9

TYPICAL CHARACTERISTICS

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

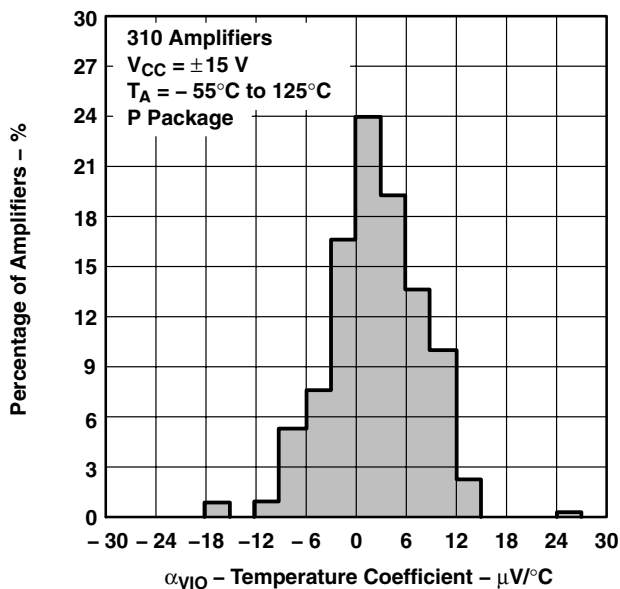


Figure 10

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

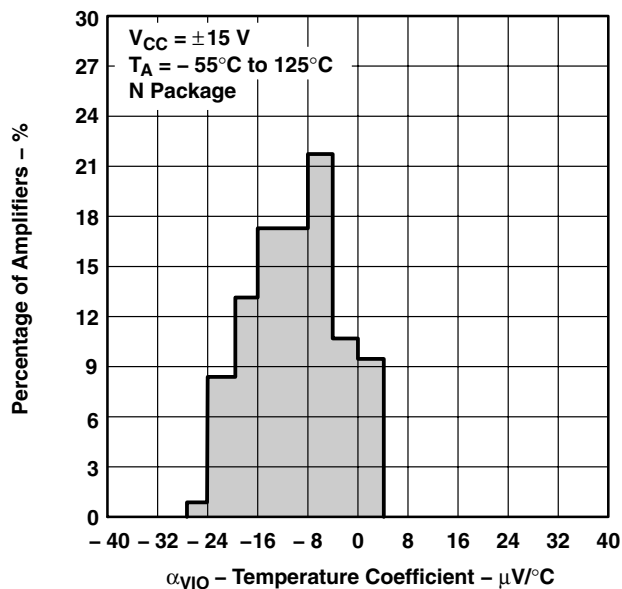


Figure 11

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

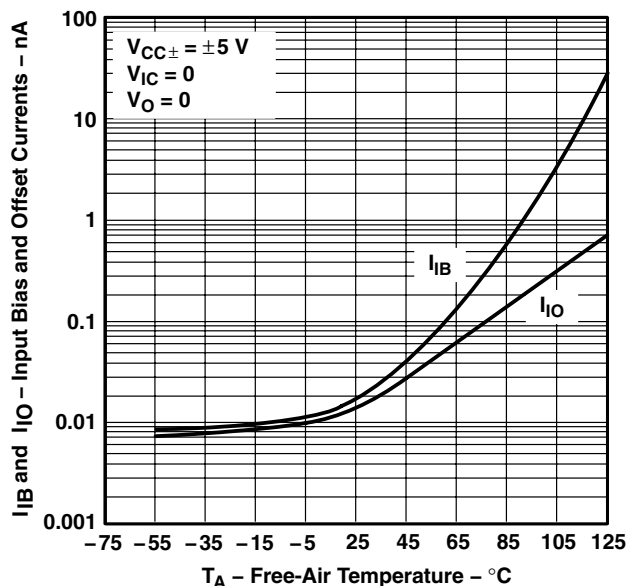


Figure 12

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

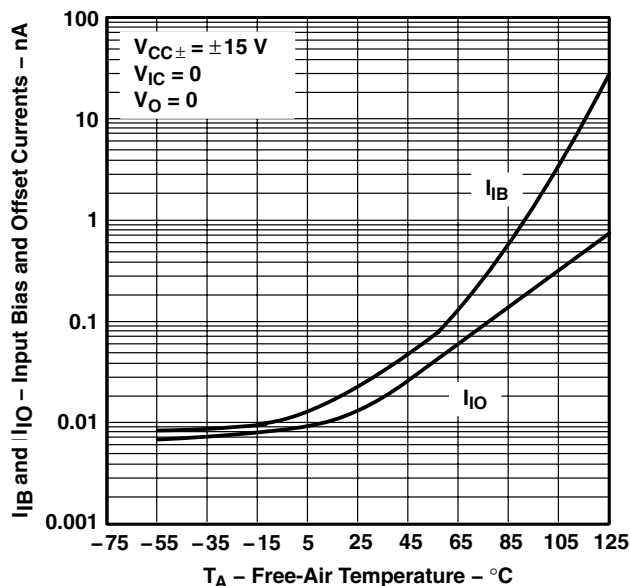


Figure 13

† 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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

TYPICAL CHARACTERISTICS

INPUT BIAS CURRENT
vs
TOTAL SUPPLY VOLTAGE

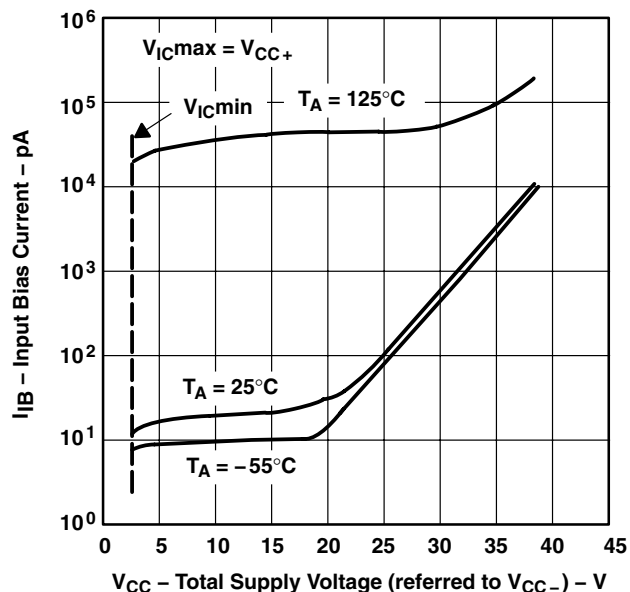


Figure 14

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

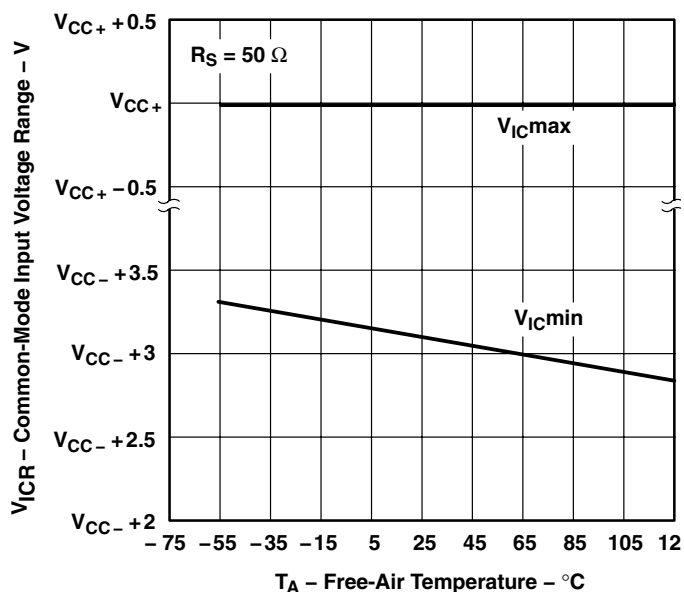


Figure 15

OUTPUT VOLTAGE
vs
DIFFERENTIAL INPUT VOLTAGE

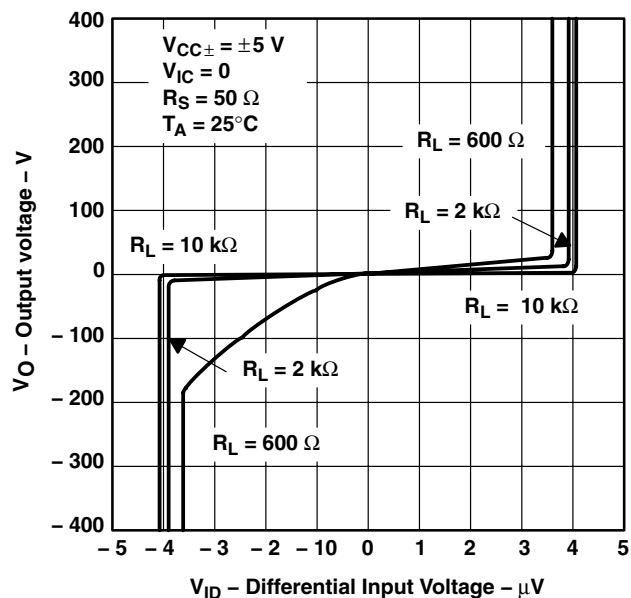


Figure 16

OUTPUT VOLTAGE
vs
DIFFERENTIAL INPUT VOLTAGE

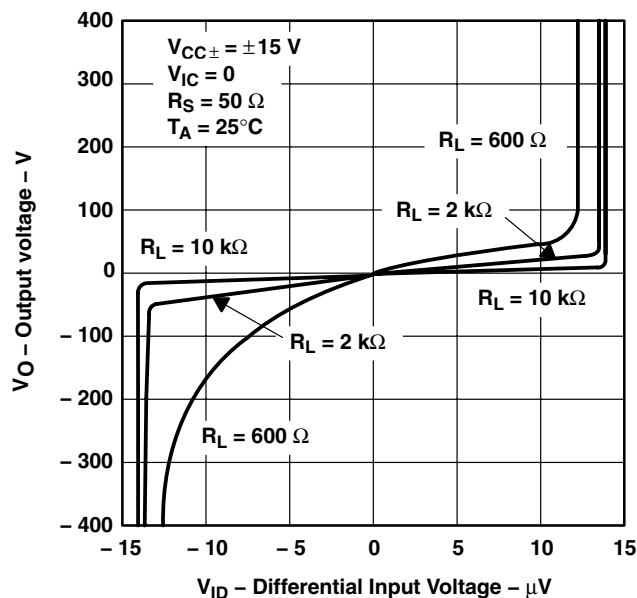


Figure 17

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

TYPICAL CHARACTERISTICS

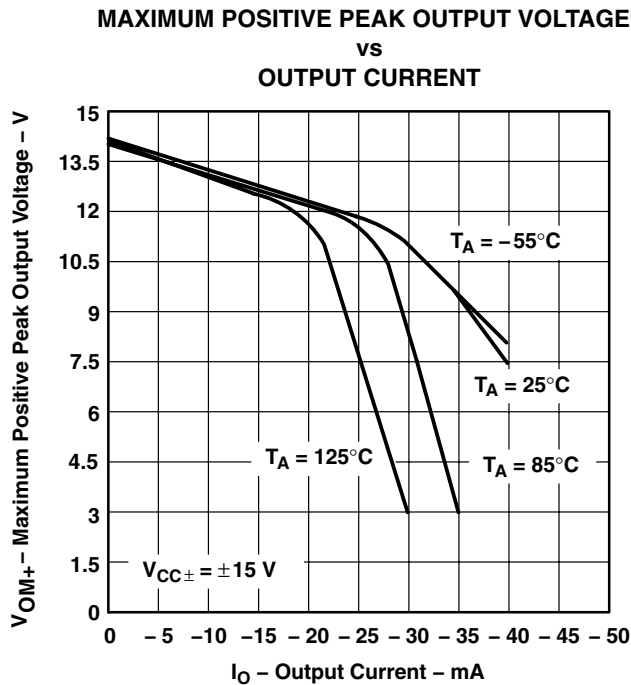


Figure 18

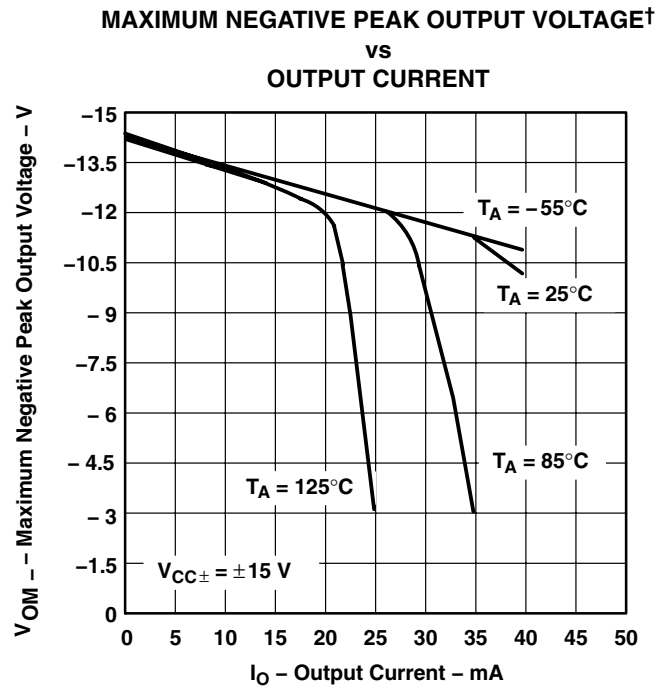


Figure 19

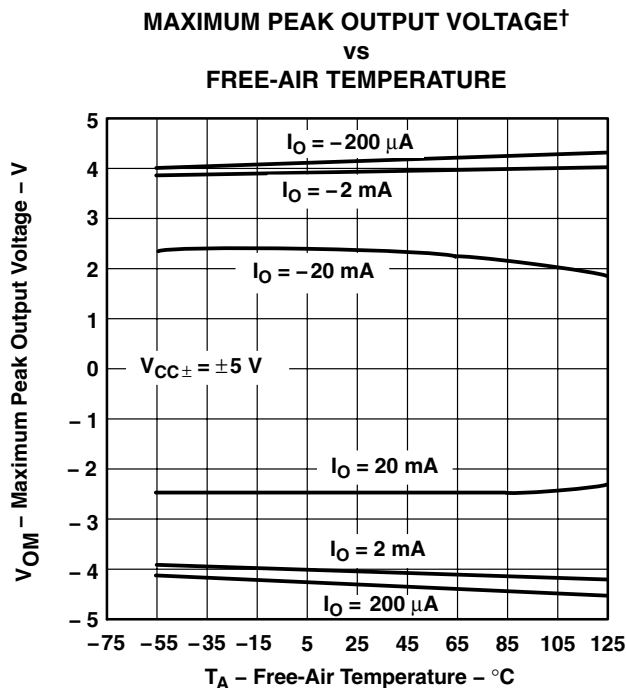


Figure 20

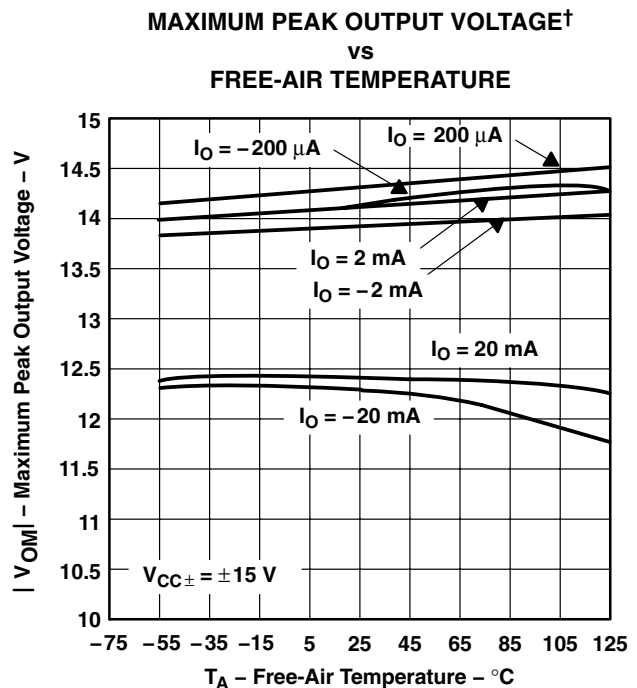


Figure 21

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

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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

TYPICAL CHARACTERISTICS

MAXIMUM PEAK OUTPUT VOLTAGE
vs
SUPPLY VOLTAGE

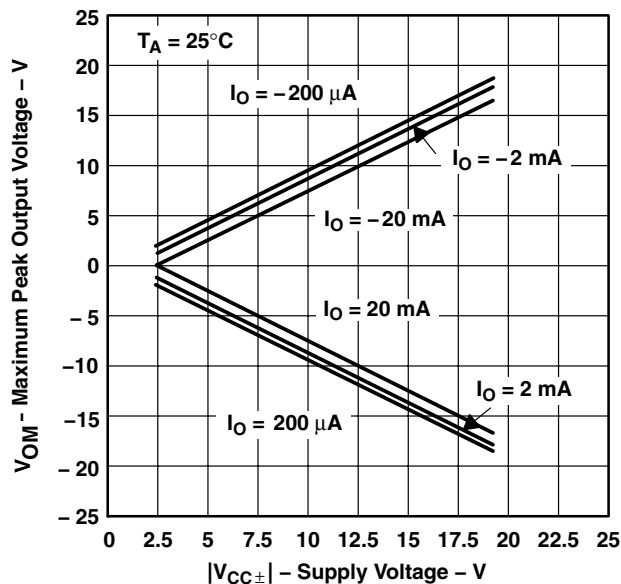


Figure 22

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE†
vs
FREQUENCY

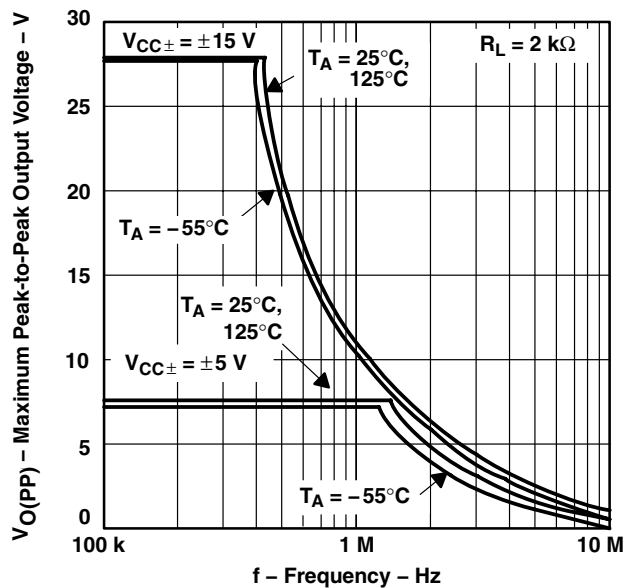


Figure 23

OUTPUT VOLTAGE
vs
SETTLING TIME

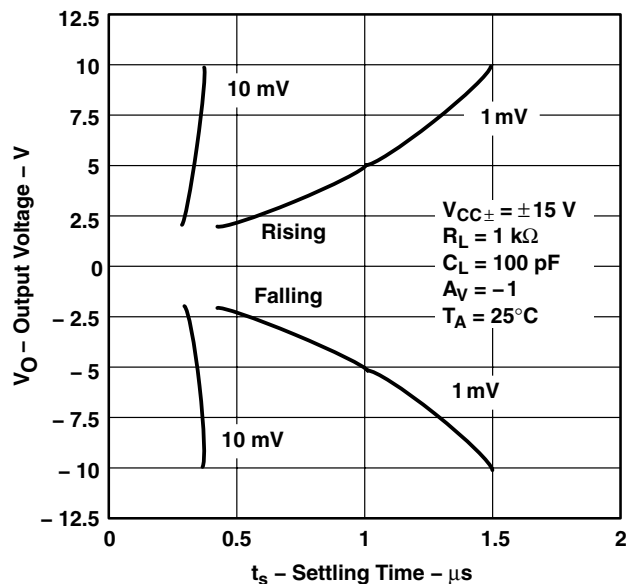


Figure 24

LARGE-SIGNAL DIFFERENTIAL
VOLTAGE AMPLIFICATION
vs
LOAD RESISTANCE

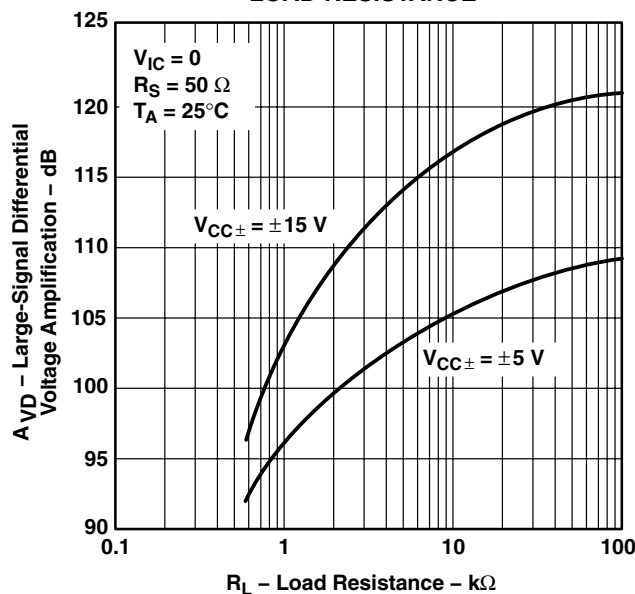


Figure 25

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

TYPICAL CHARACTERISTICS

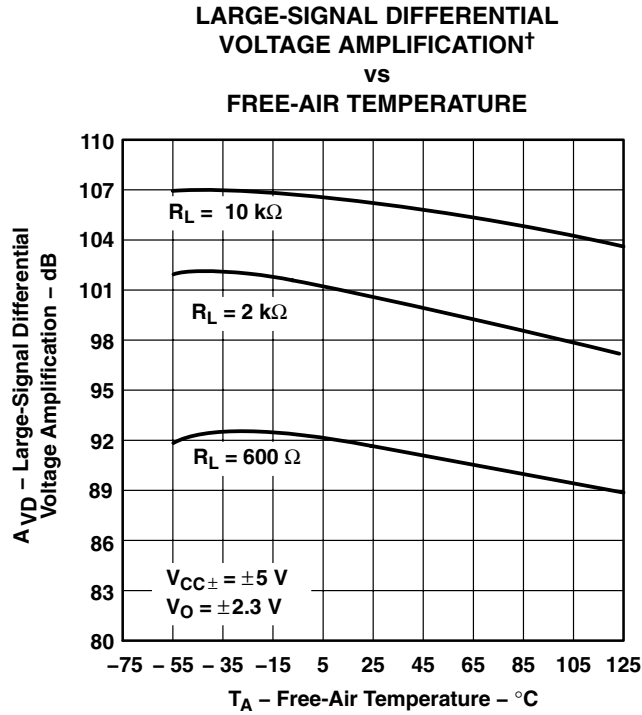


Figure 26

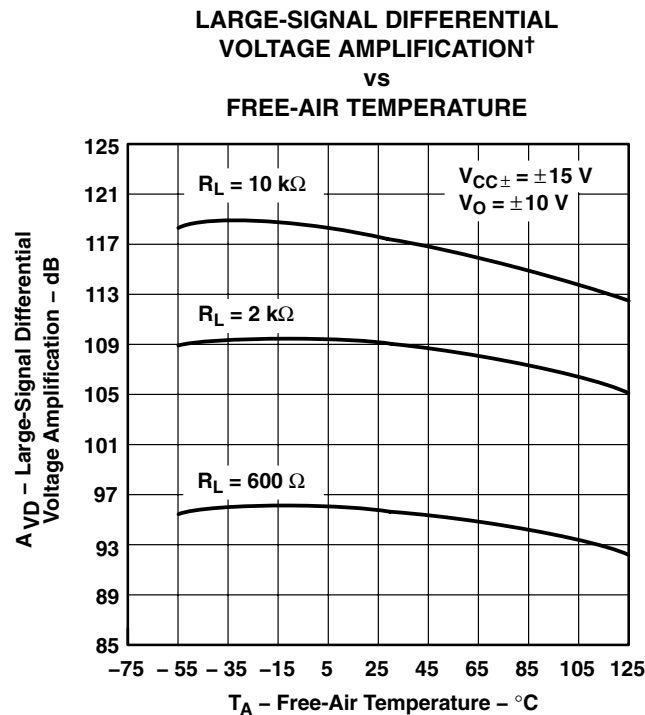


Figure 27

† 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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

TYPICAL CHARACTERISTICS

SMALL-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT

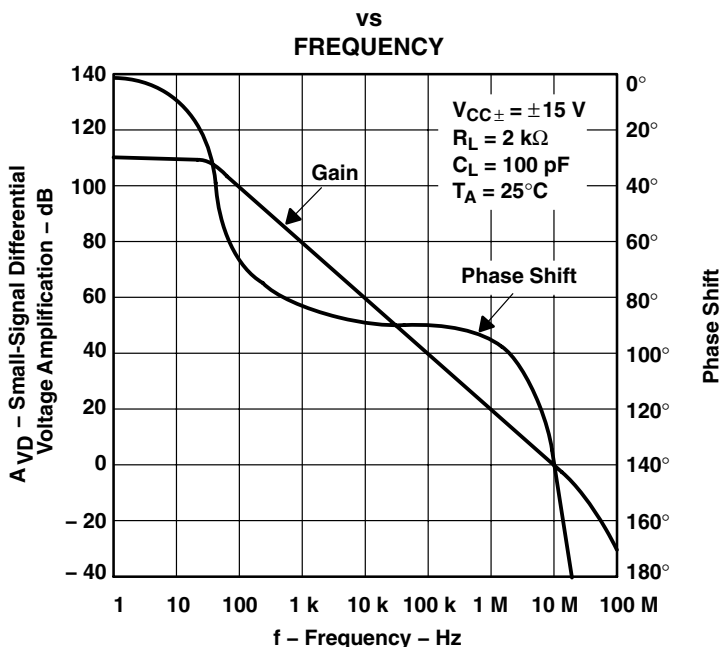


Figure 28

SMALL-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT

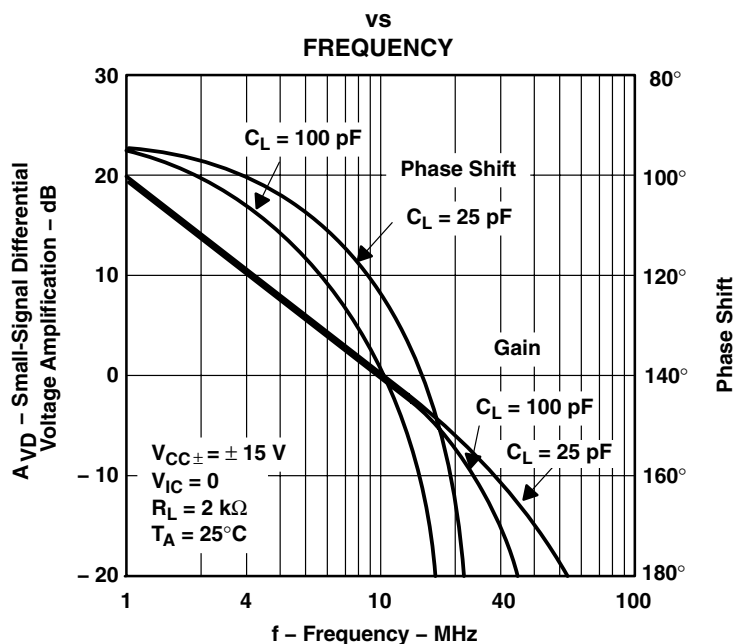
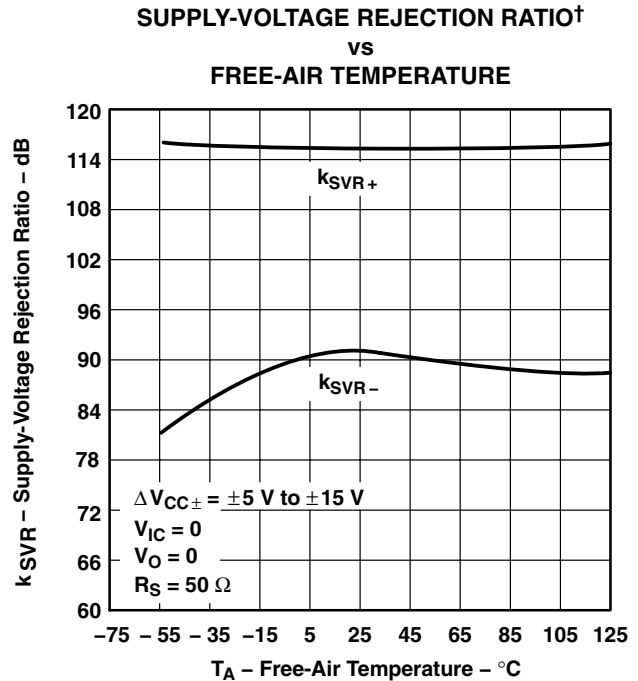
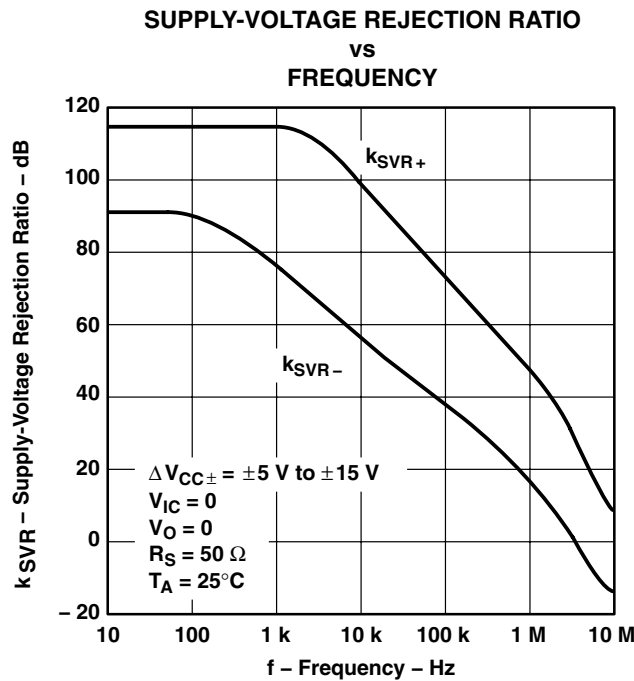
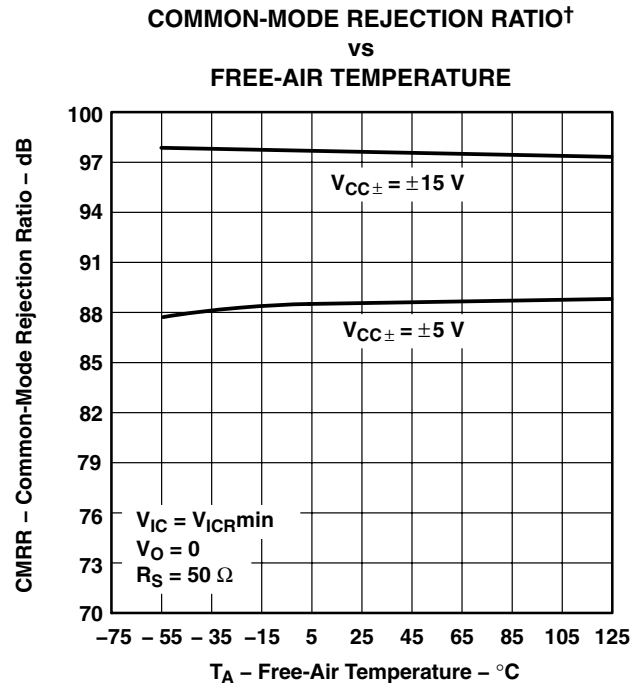
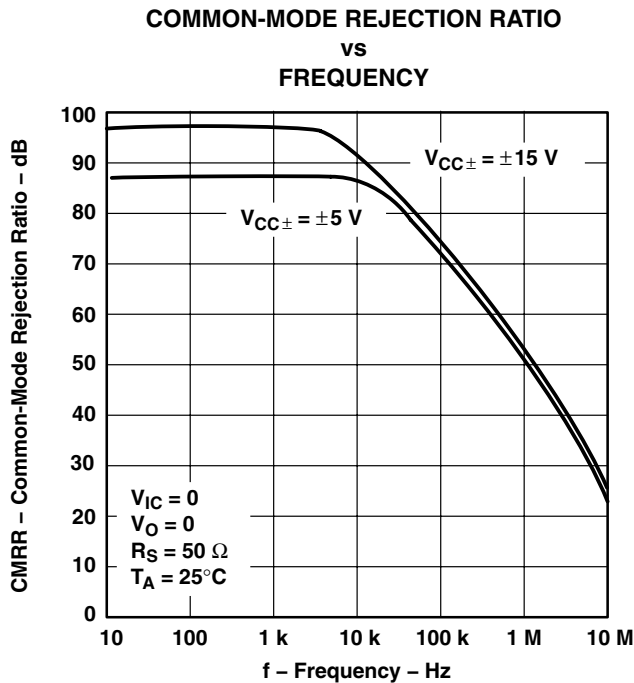


Figure 29

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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

TYPICAL CHARACTERISTICS

**TLE2071
SUPPLY CURRENT
vs
SUPPLY VOLTAGE**

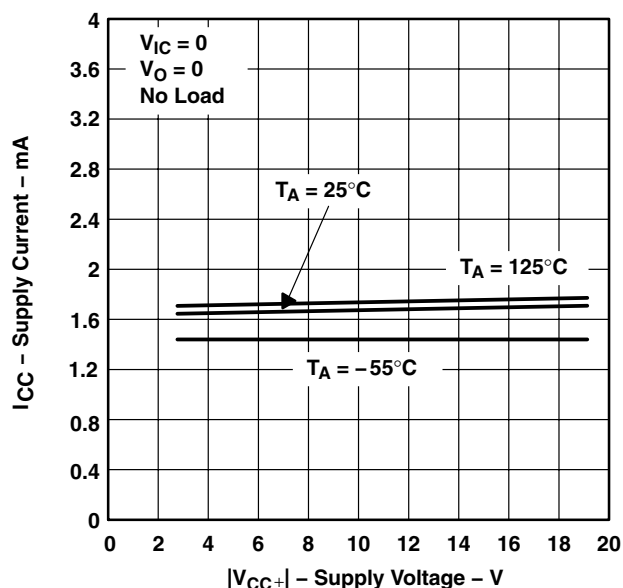


Figure 34

**TLE2072
SUPPLY CURRENT
vs
SUPPLY VOLTAGE**

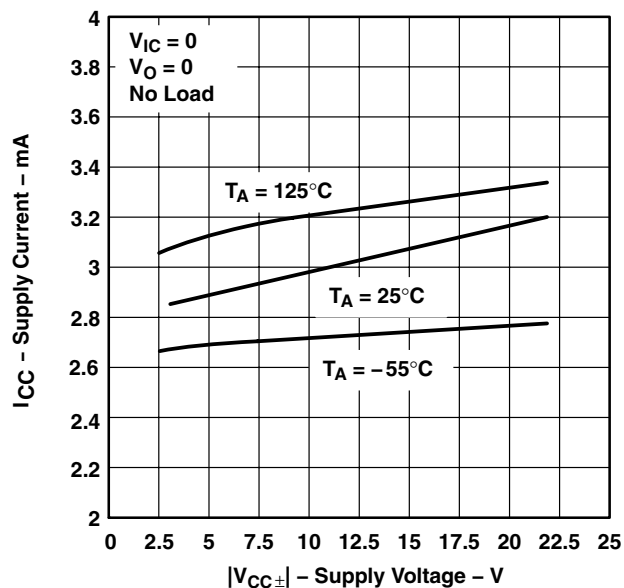


Figure 35

**TLE2074
SUPPLY CURRENT
vs
SUPPLY VOLTAGE**

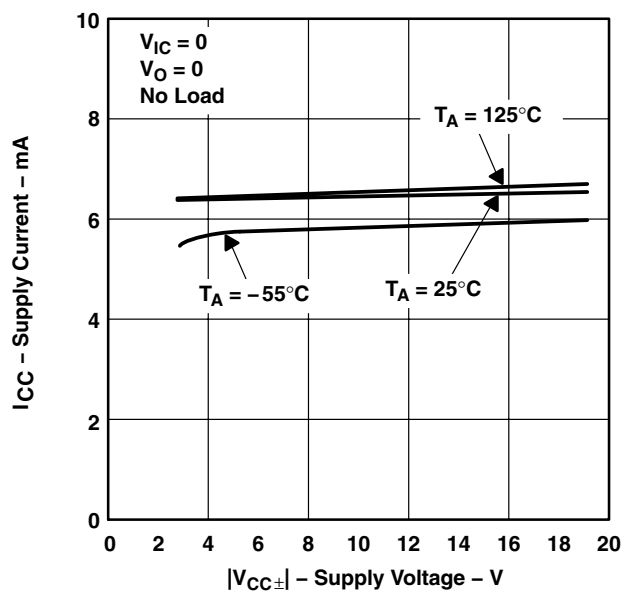


Figure 36

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

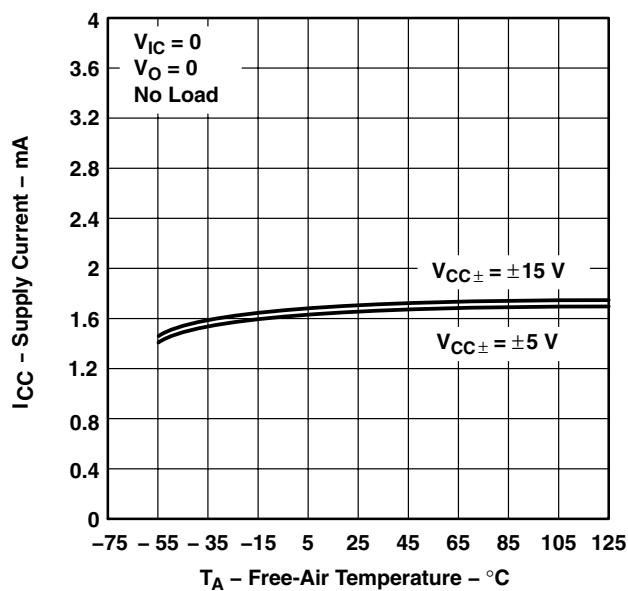


Figure 37

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

TYPICAL CHARACTERISTICS

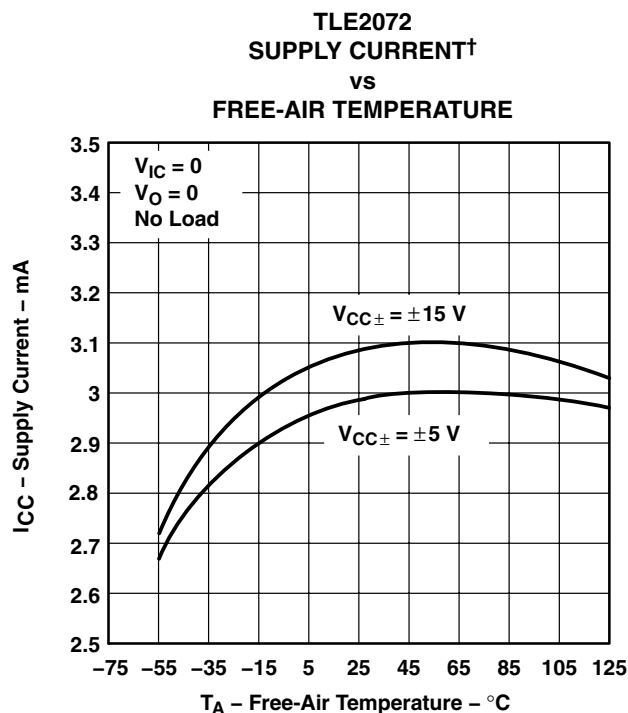


Figure 38

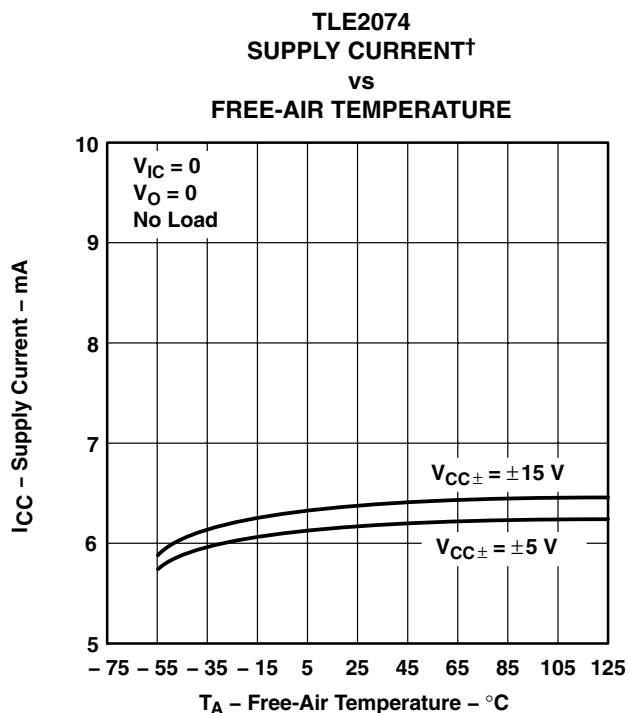


Figure 39

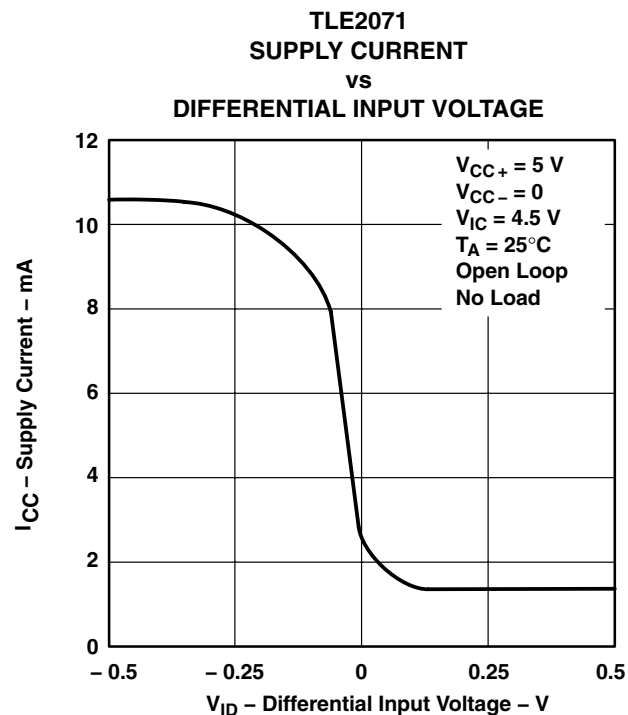


Figure 40

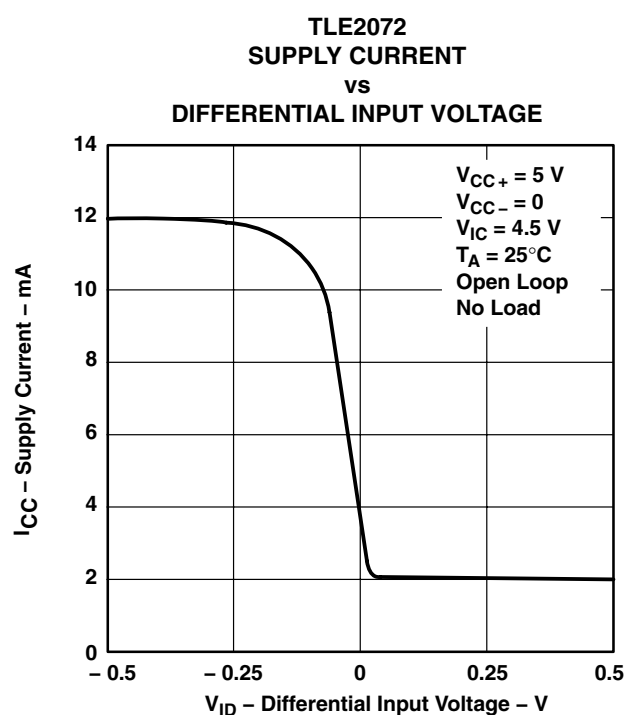


Figure 41

† 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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

TYPICAL CHARACTERISTICS

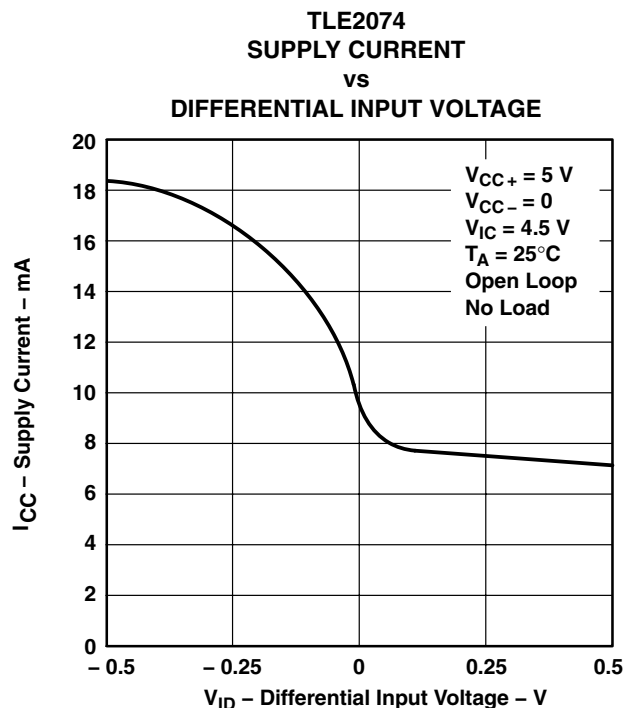


Figure 42

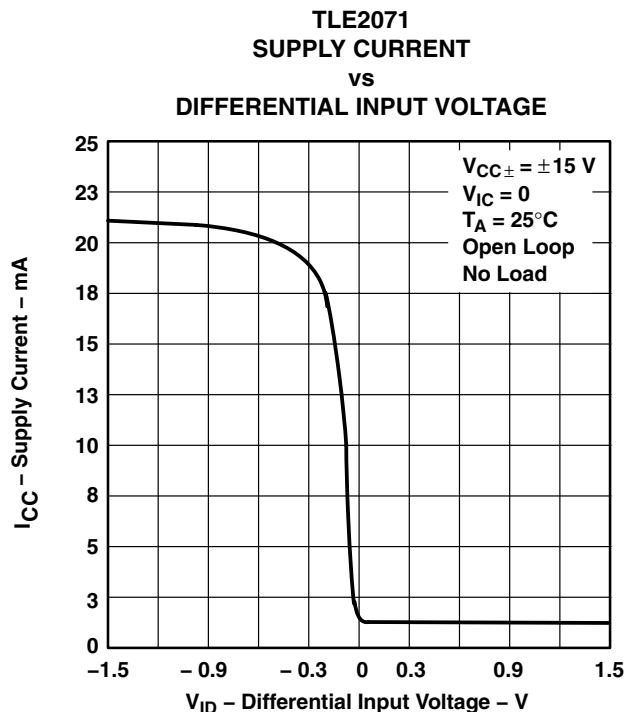


Figure 43

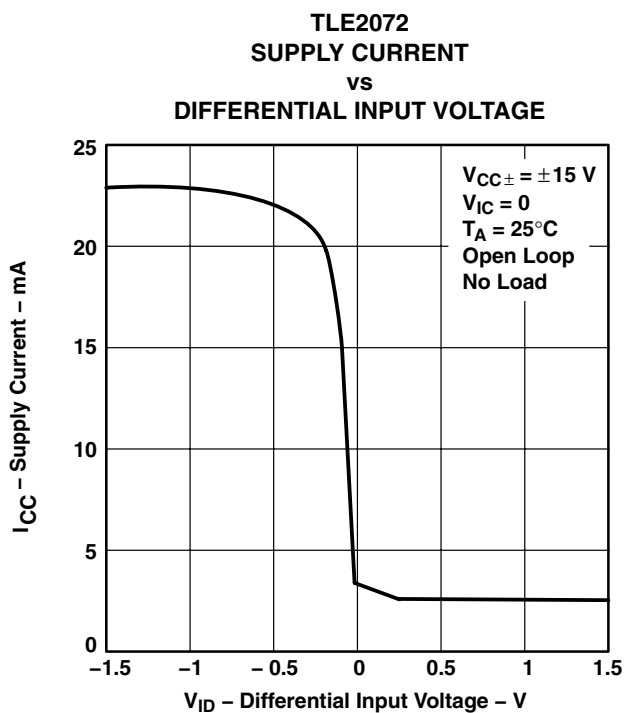


Figure 44

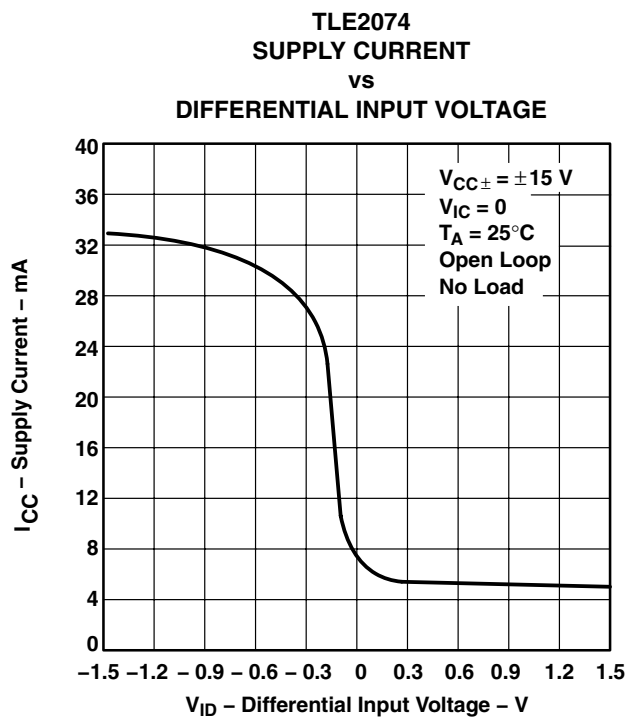
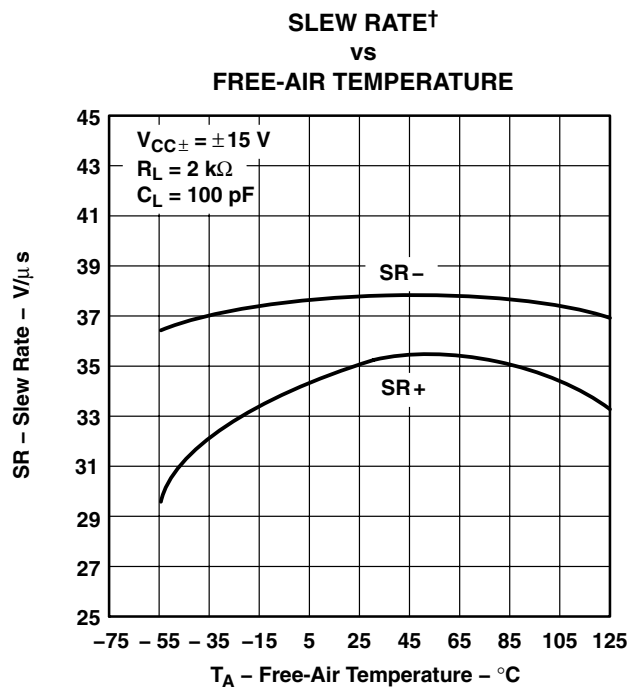
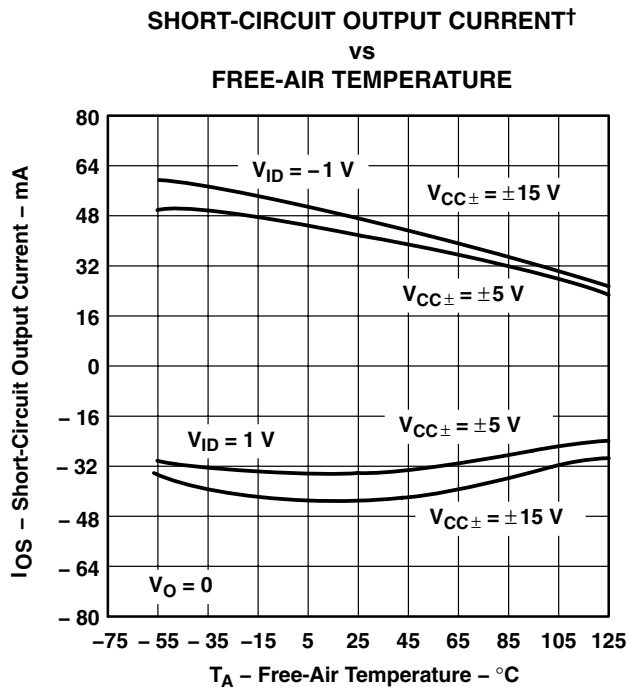
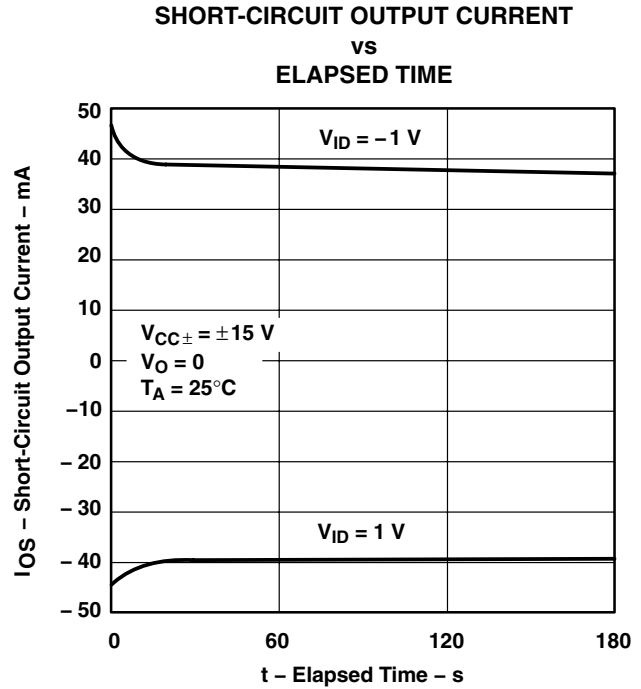
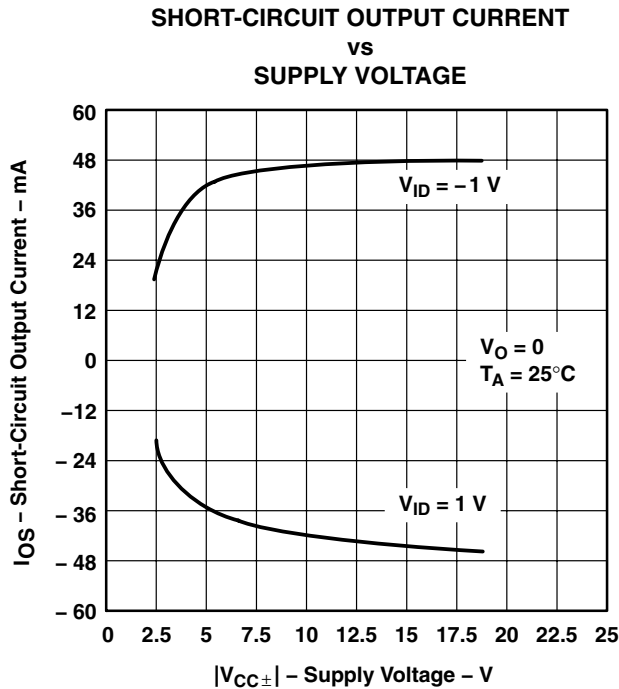


Figure 45

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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

TYPICAL CHARACTERISTICS

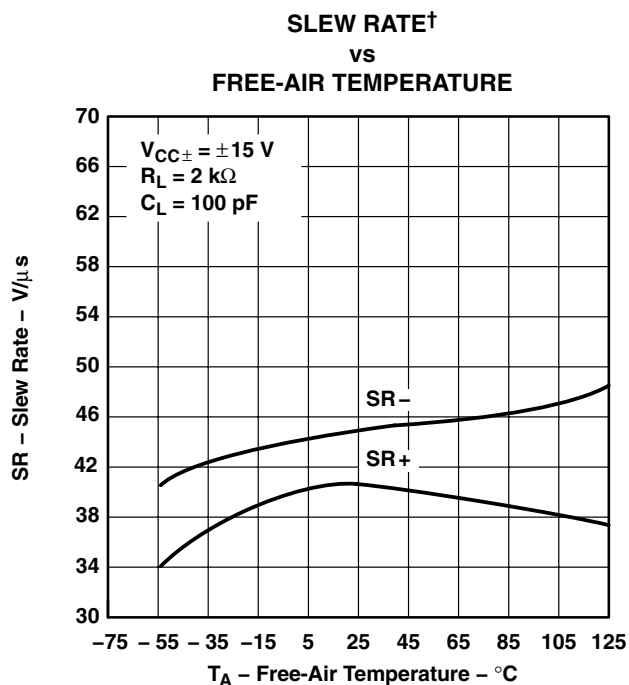


Figure 50

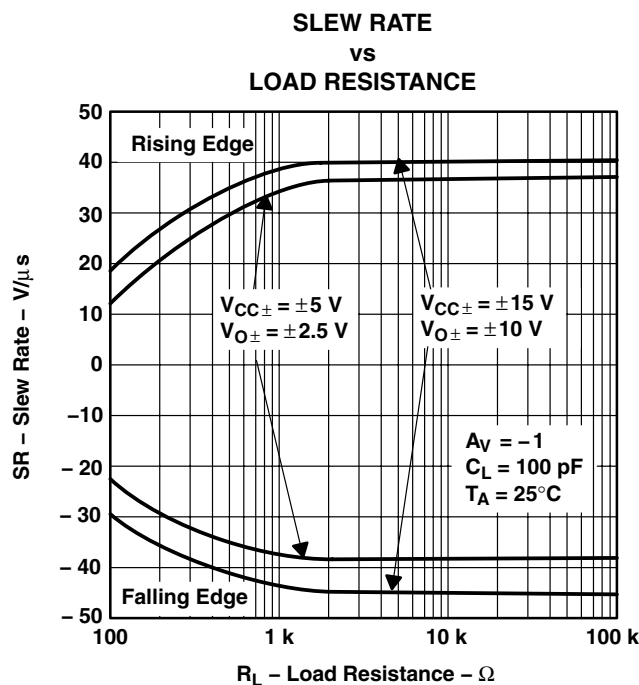


Figure 51

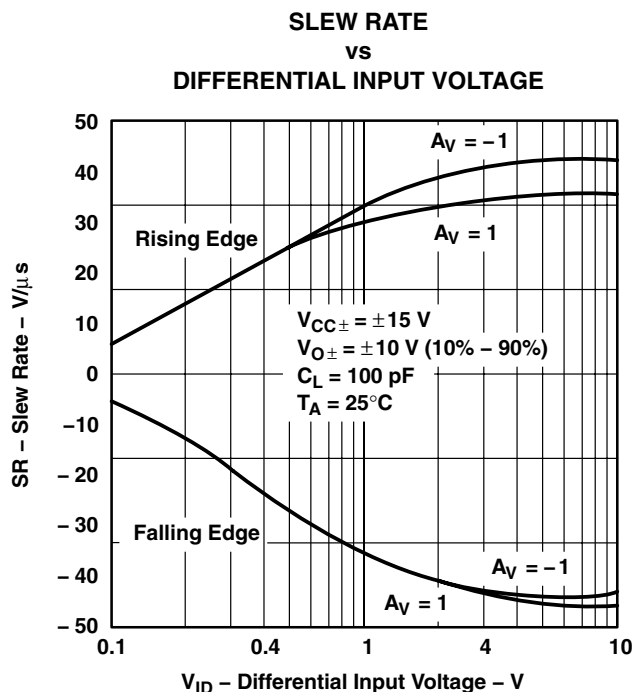


Figure 52

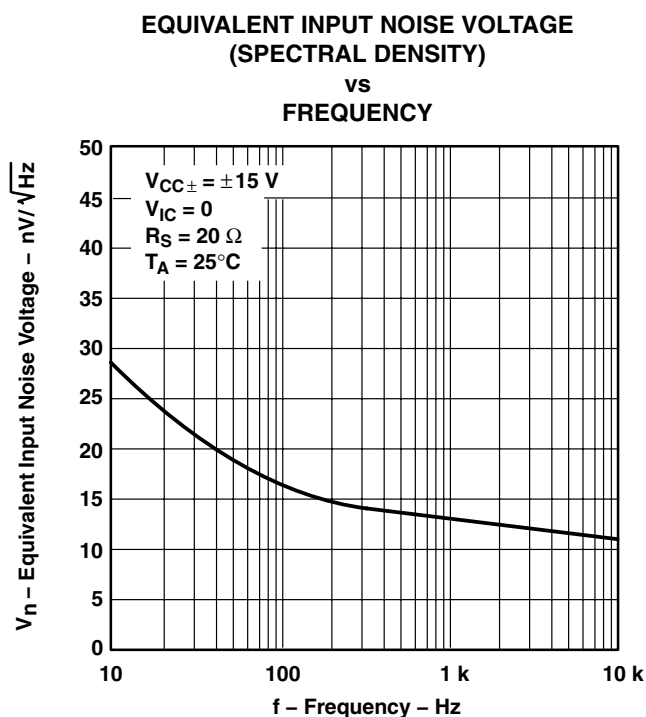
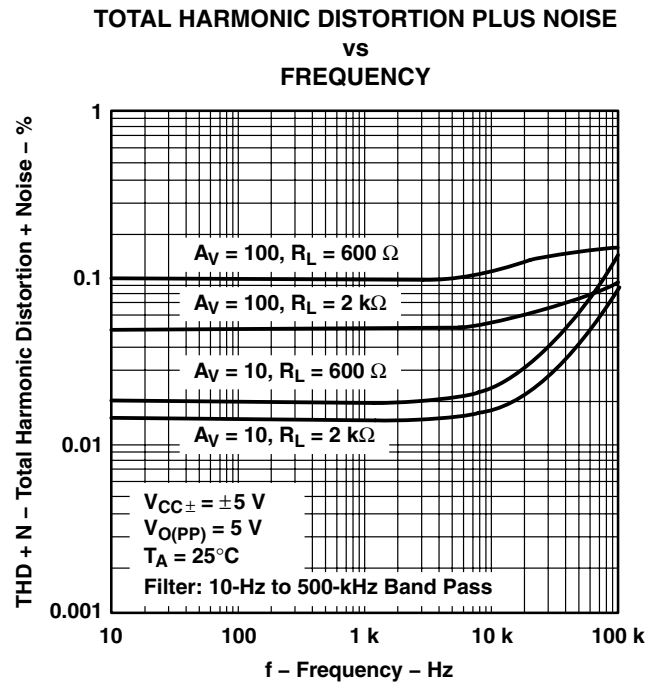
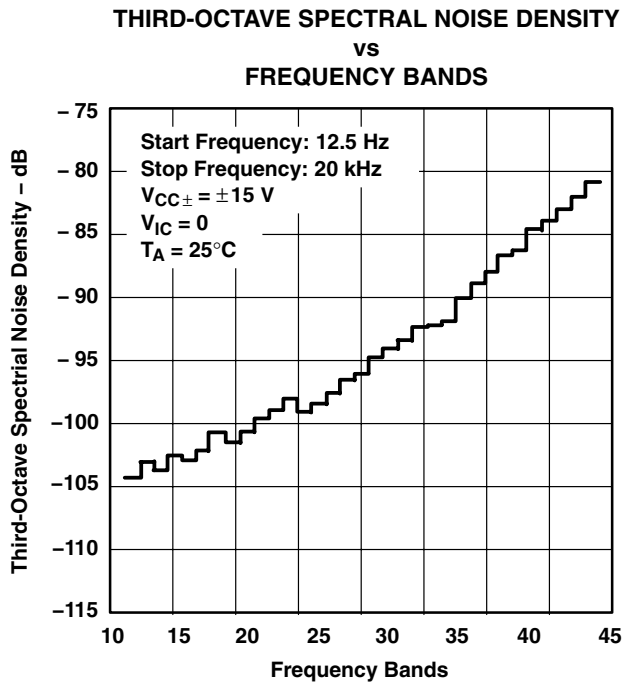
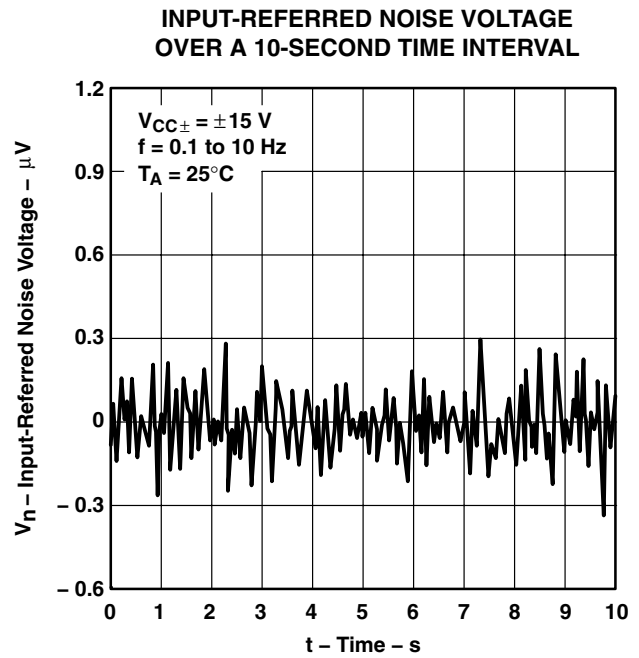
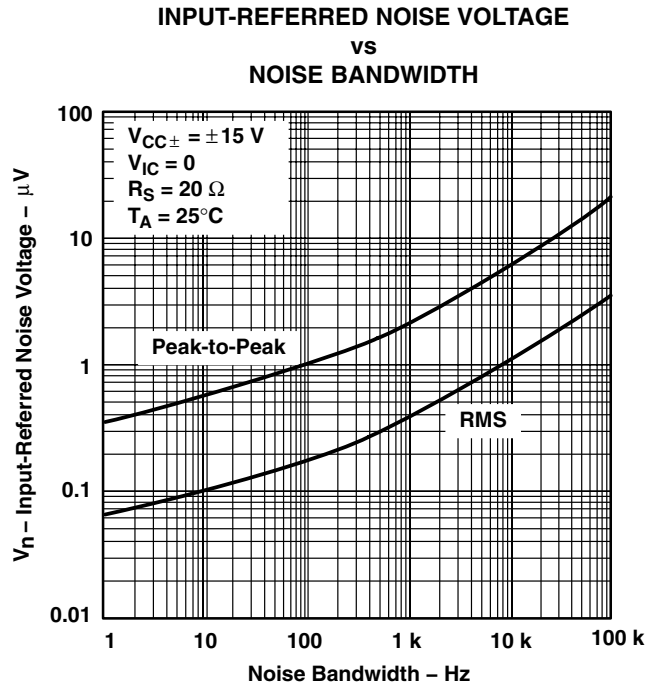


Figure 53

† 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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

TYPICAL CHARACTERISTICS

**TOTAL HARMONIC DISTORTION PLUS NOISE
vs
FREQUENCY**

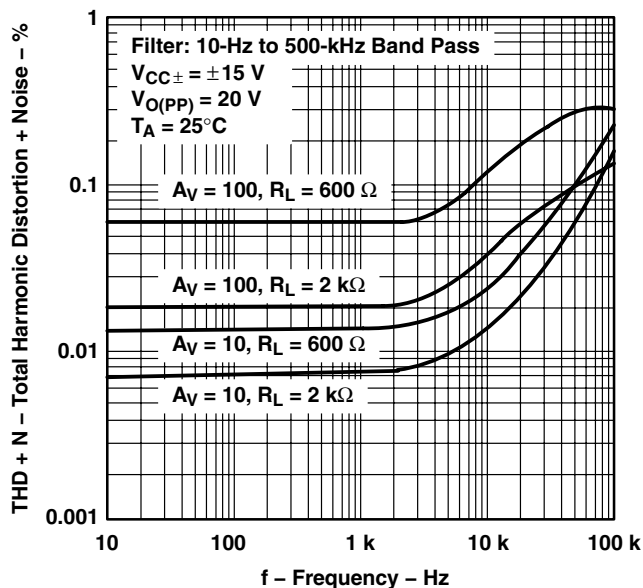


Figure 58

**UNITY-GAIN BANDWIDTH
vs
LOAD CAPACITANCE**

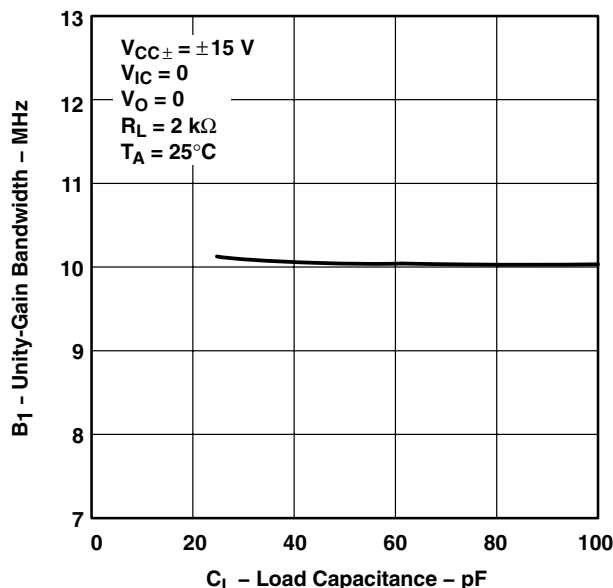


Figure 59

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

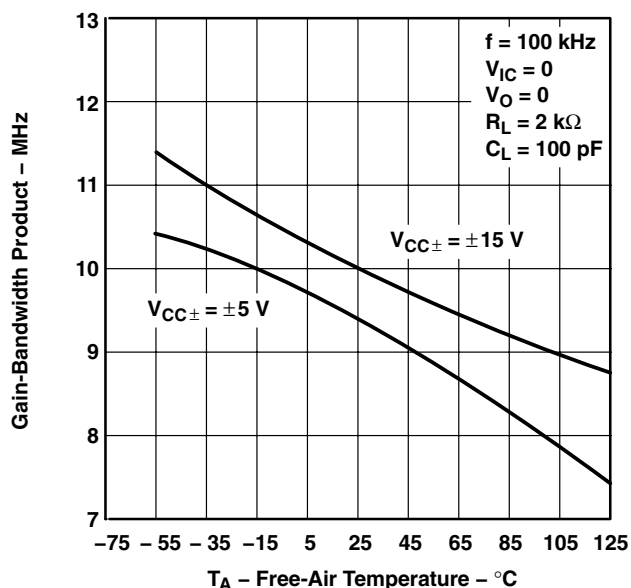


Figure 60

**GAIN-BANDWIDTH PRODUCT
vs
SUPPLY VOLTAGE**

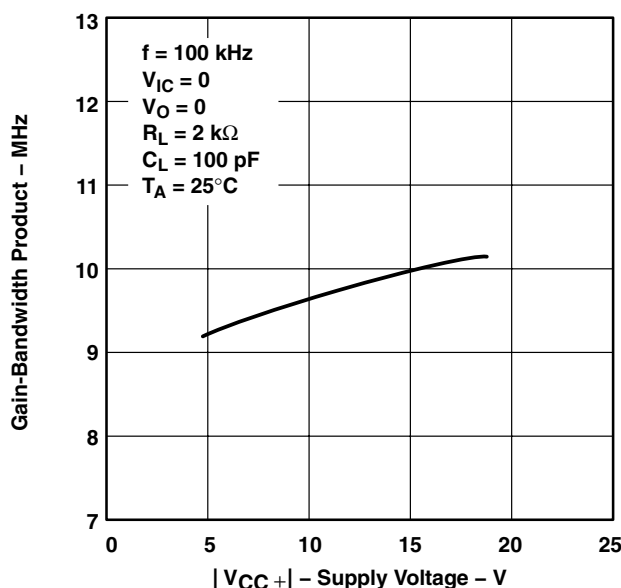


Figure 61

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

TYPICAL CHARACTERISTICS

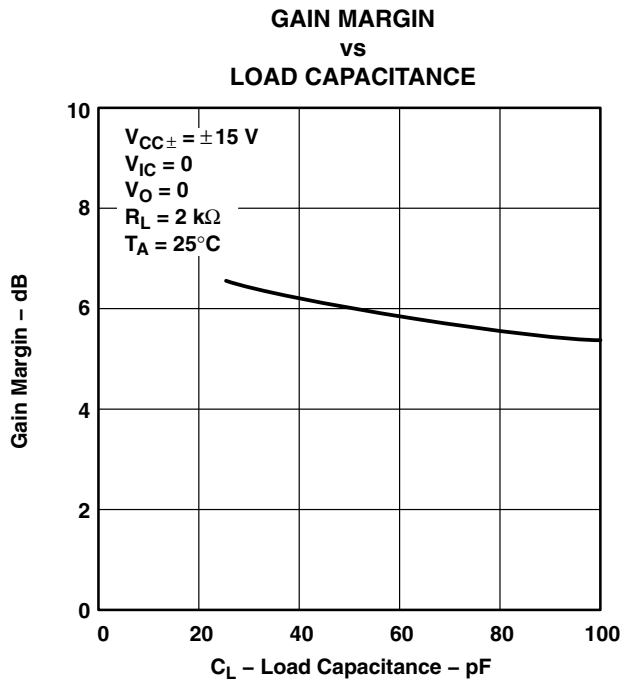


Figure 62

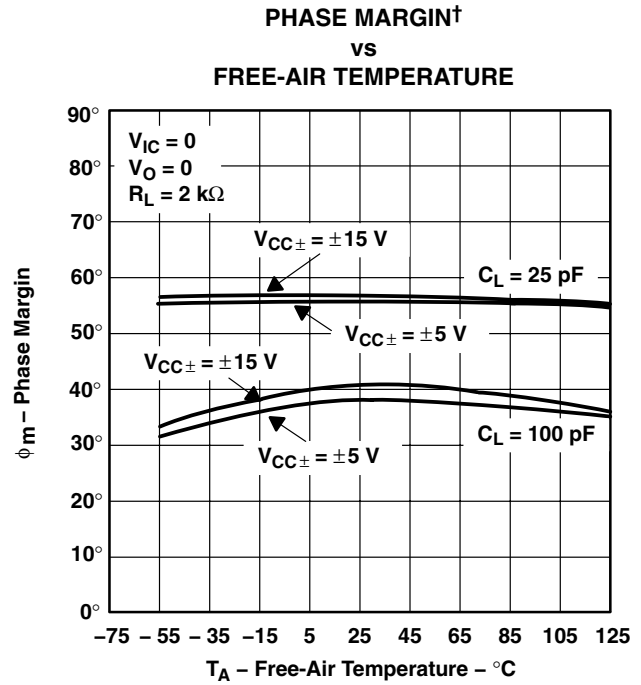


Figure 63

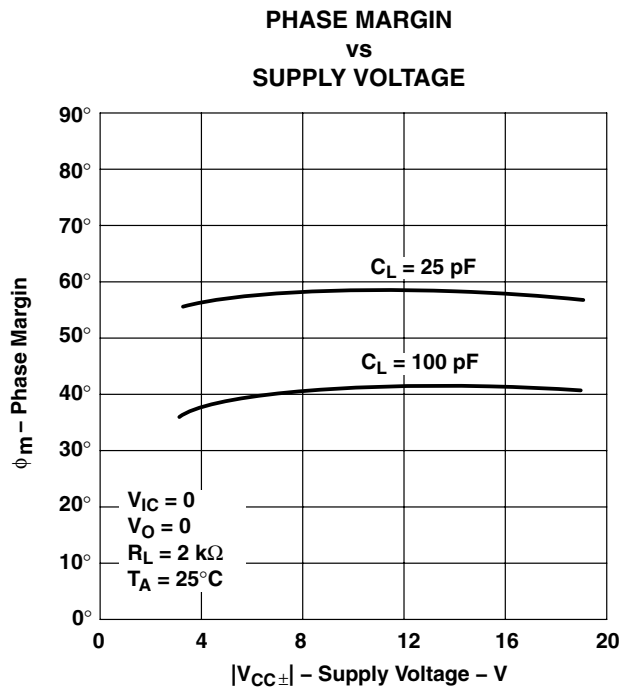


Figure 64

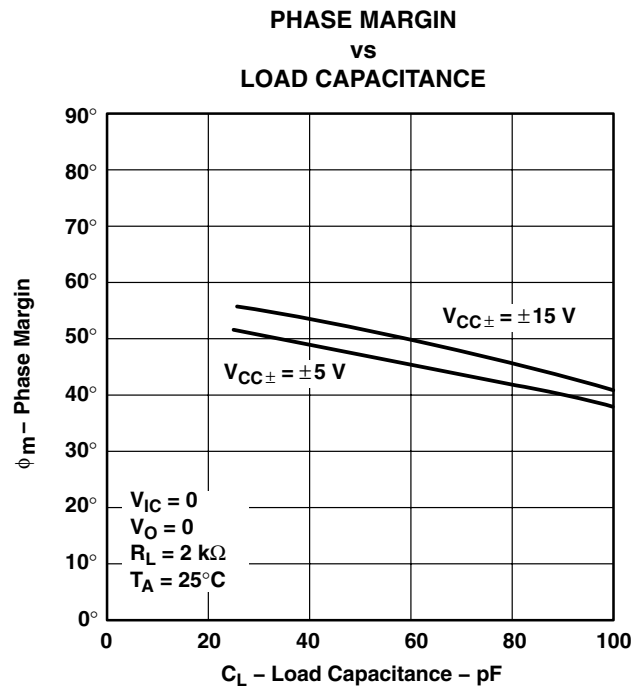


Figure 65

† 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†

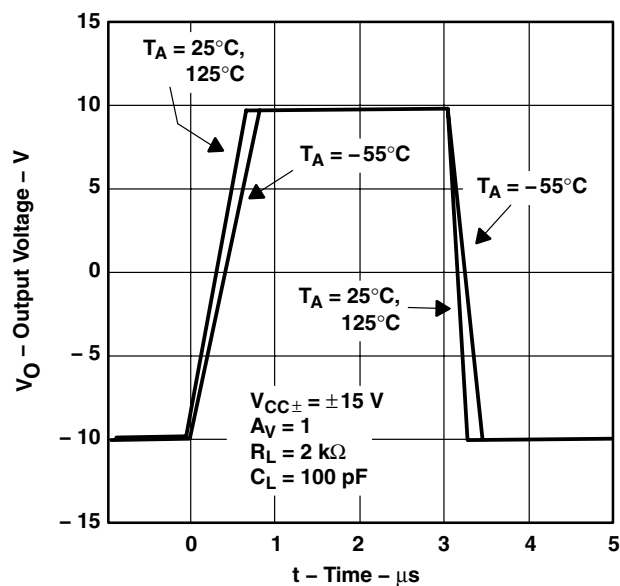


Figure 66

SMALL-SIGNAL PULSE RESPONSE

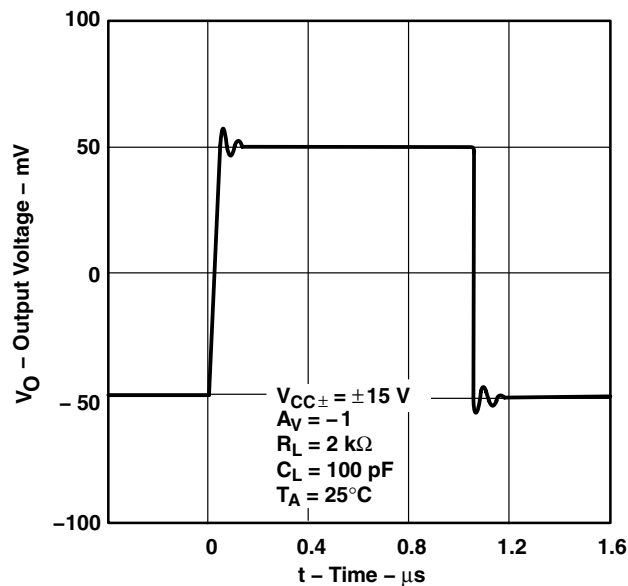


Figure 67

CLOSED-LOOP OUTPUT IMPEDANCE
vs
FREQUENCY

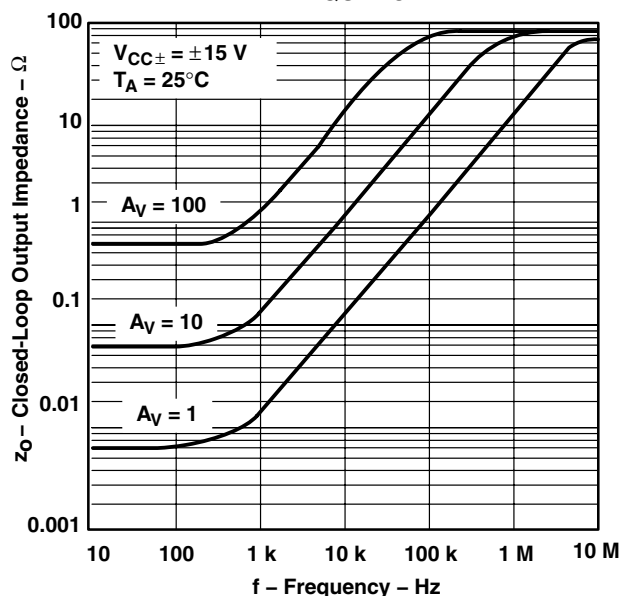


Figure 68

TLE2072 AND TLE2074
CROSSTALK ATTENUATION
vs
FREQUENCY

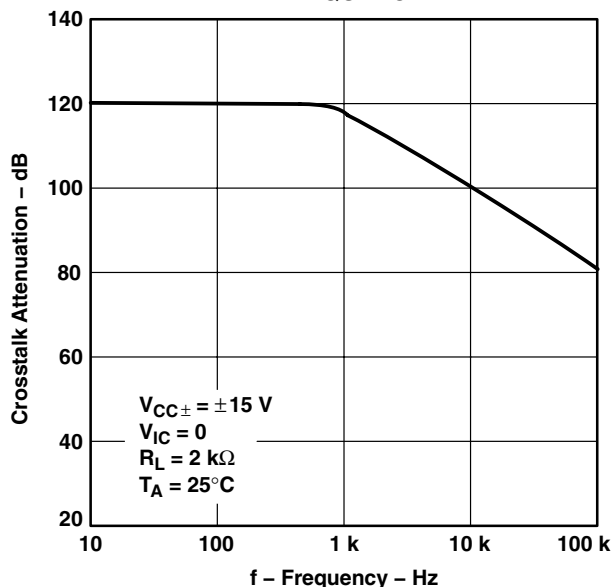


Figure 69

† 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.

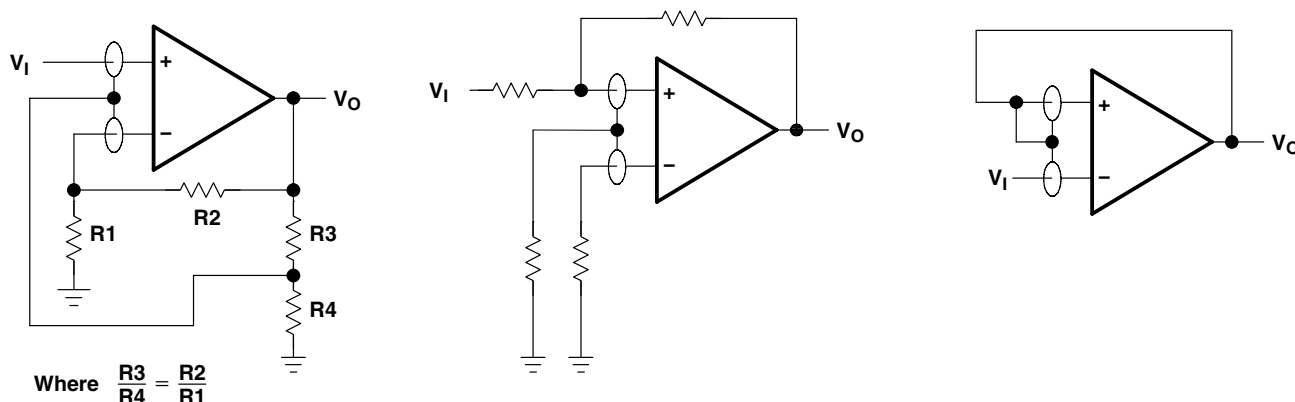


Figure 70. Use of Guard Rings

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.

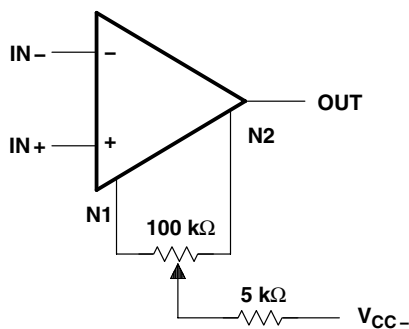


Figure 71. Input Offset Voltage Nulling

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

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

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).

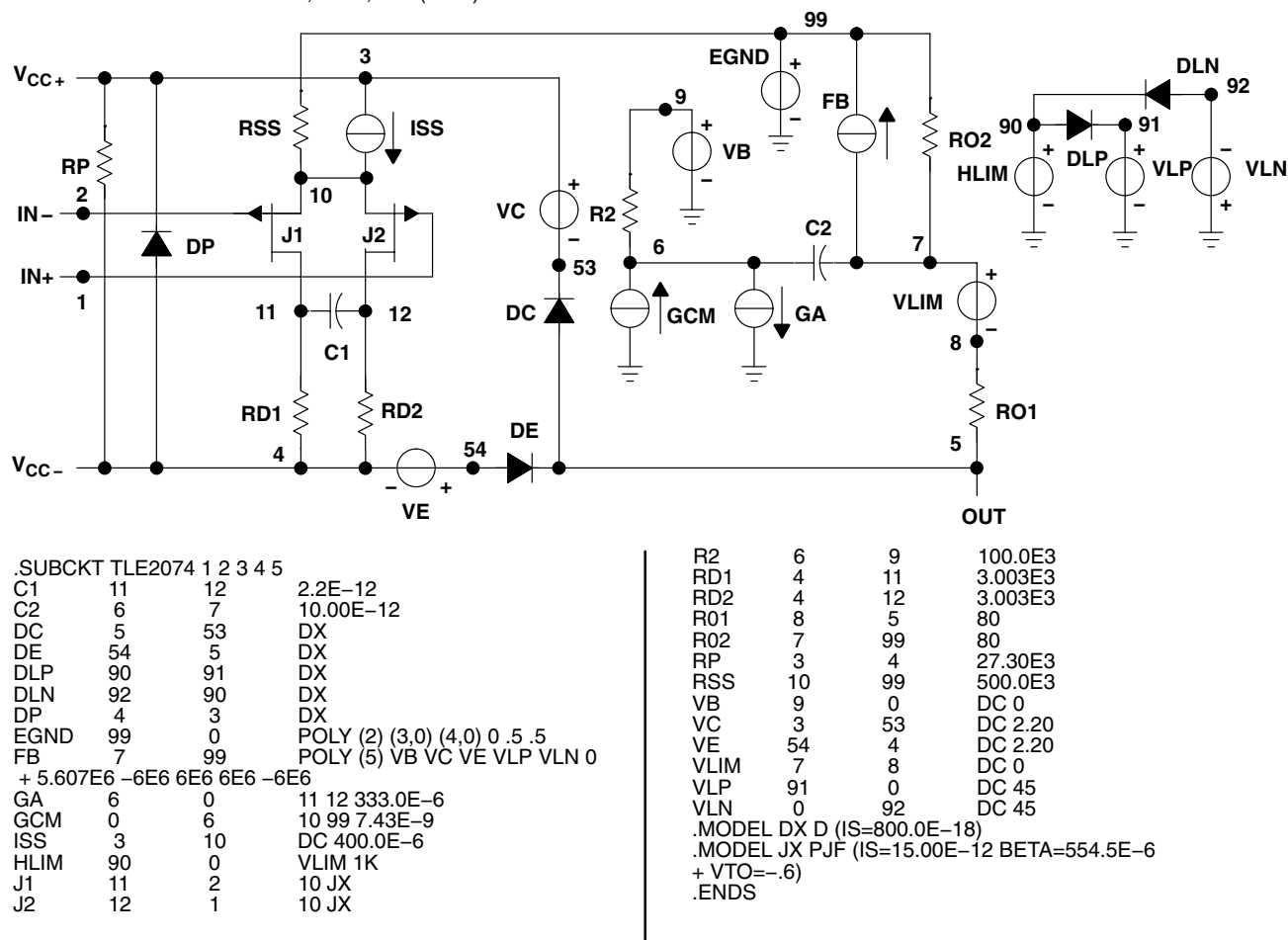


Figure 72. Boyle Macromodel and Subcircuit

PSpice and *Parts* are trademarks of MicroSim Corporation.



PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	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
TLE2072AQDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	2072AQ	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.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and

continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

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

- Catalog: [TLE2071A](#), [TLE2072A](#)
- Military: [TLE2071AM](#), [TLE2072AM](#)

NOTE: Qualified Version Definitions:

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



PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



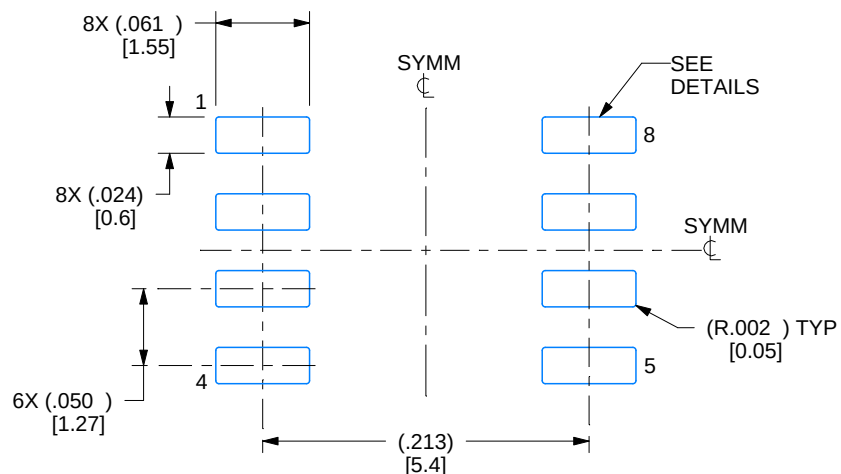
1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.

EXAMPLE BOARD LAYOUT

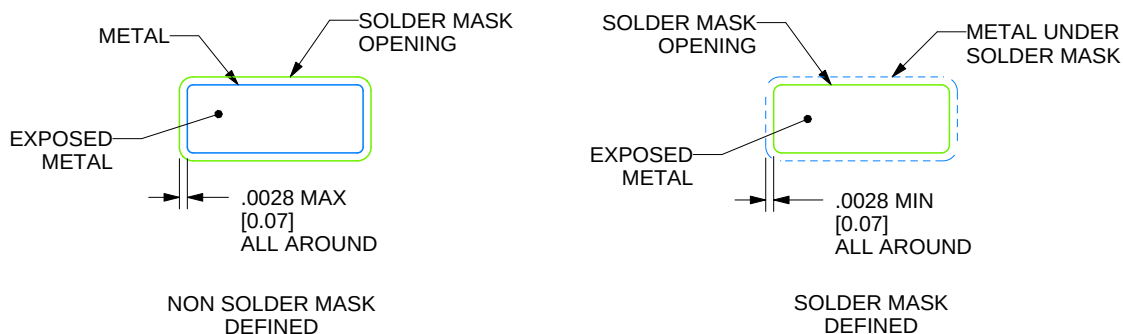
D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

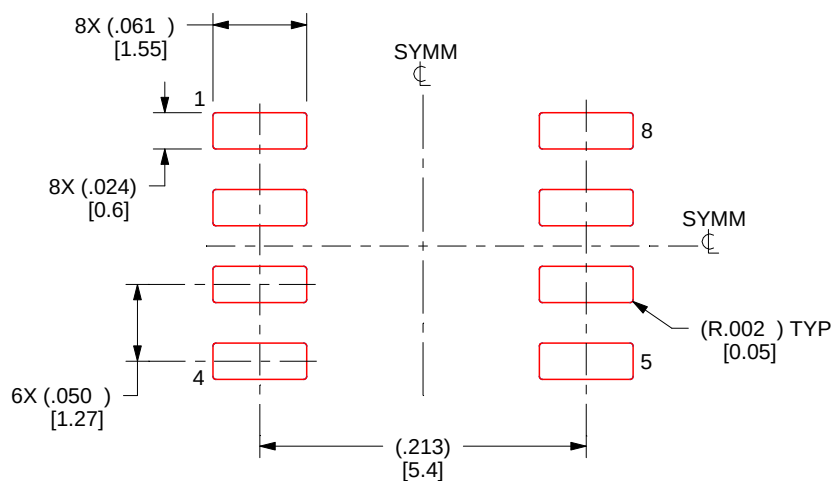
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2019, Texas Instruments Incorporated

Looking for pricing, stock, or lifecycle information?

Click below to explore more details on WIN SOURCE:

 View [TLE2072QDRQ1](#) on WIN SOURCE

 [Texas Instruments](#) Information

Optimize Your Supply Chain with WIN SOURCE Solutions

-  Global Sourcing Solution
-  Obsolete Management
-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management