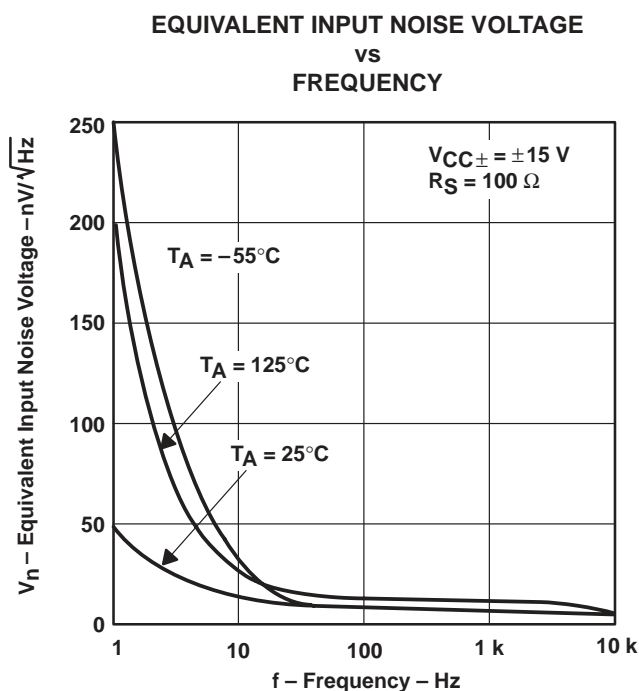
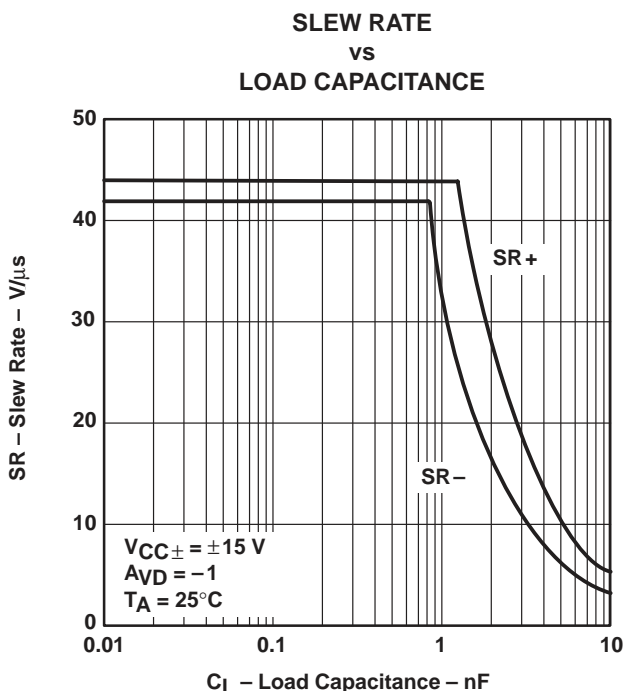


TLE2141M, TLE2141AM EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

SGLS059 – NOVEMBER 1990 – REVISED OCTOBER 1991

available features

- Low Noise:
10 Hz ... 15 nV/√Hz
1 kHz ... 10.5 nV/√Hz
- 10000-pF Load Capability
- 20-mA Min Short-Circuit Output Current
- 30-V/μs Min Slew Rate
- High Gain-Bandwidth Product ... 5.9 MHz
- Low V_{IO} ... 500 μV Max at 25°C
- Single or Split Supply ... 4 V to 44 V
- Fast Settling Time
340 ns to 0.1%
400 ns to 0.01%
- Saturation Recovery ... 150 ns
- Large Output Swing ... $V_{CC-} + 0.1$ V
to $V_{CC+} - 1$ V



description

The TLE2141M and TLE2141AM are high-performance, internally compensated operational amplifiers built using Texas Instruments complementary bipolar Excalibur process. The TLE2141AM is a tighter offset voltage grade of the TLE2141M. Both are pin-compatible upgrades to standard industry products.

The design incorporates a patent-pending input stage that simultaneously achieves low audio band noise of 10.5 nV/√Hz with a 10-Hz 1/f corner and symmetrical 40-V/μs slew rate typically with loads up to 800 pF. The resulting low distortion and high power bandwidth are important in high-fidelity audio applications. A fast settling time of 340 ns to 0.1% of a 10-V step with a 2-kΩ/100-pF load is useful in fast actuator/positioning drivers. Under similar test conditions, settling time to 0.01% is 400 ns.

AVAILABLE OPTIONS

T_A	V_{IO} max AT 25°C	PACKAGE		CHIP FORM (Y)
		CHIP CARRIER (FK)	CERAMIC DIP (JG)	
-55°C to 125°C	500 μV	TLE2141AMFK	TLE2141AMJG	TLE2141Y
	900 μV	TLE2141MFK	TLE2141MJG	

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.



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TLE2141M, TLE2141AM EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

SGLS059 – NOVEMBER 1990 – REVISED OCTOBER 1991

description (continued)

The devices are stable with capacitive loads up to 10 nF, although the 6-MHz bandwidth decreases to 1.8 MHz at this high loading level. As such, the TLE2141M and TLE2141AM are useful for low-droop sample and holds and direct buffering of long cables, including four 20-mA current loops.

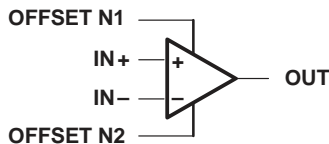
The special design also exhibits an improved insensitivity to inherent IC component mismatches as is evidenced by a 500- μ V maximum offset voltage and 1.7- μ V/ $^{\circ}$ C typical drift. Minimum common-mode rejection ratio and supply-voltage rejection ratio are 85 dB and 90 dB, respectively.

Device performance is relatively independent of supply voltage over the ± 2 -V to ± 22 -V range. Inputs can operate between $V_{CC-} - 0.3$ to $V_{CC+} - 1.8$ V without inducing phase reversal, although excessive input current may flow out of each input exceeding the lower common-mode input range. The all NPN output stage provides a nearly rail-to-rail output swing of $V_{CC-} + 0.1$ to $V_{CC+} - 1$ V under light current loading conditions. The device can sustain shorts to either supply since output current is internally limited, but care must be taken to ensure that maximum package power dissipation is not exceeded.

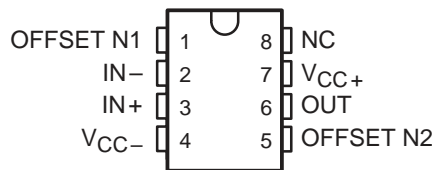
Both versions can also be used as comparators. Differential inputs of $V_{CC\pm}$ can be maintained without damage to the device. Open-loop propagation delay with TTL supply levels is typically 200 ns. This gives a good indication as to output stage saturation recovery when the device is overdriven beyond the limits of recommended output swing.

Both the TLE2141M and TLE2141AM are available in a wide variety of packages, including both the industry-standard 8-pin small-outline version and chip form for high-density system applications. The M-suffix is characterized for operation over the full military temperature range of -55° C to 125° C.

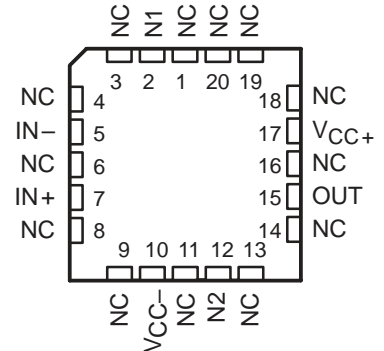
symbol



JG PACKAGE
(TOP VIEW)



FK PACKAGE
(TOP VIEW)



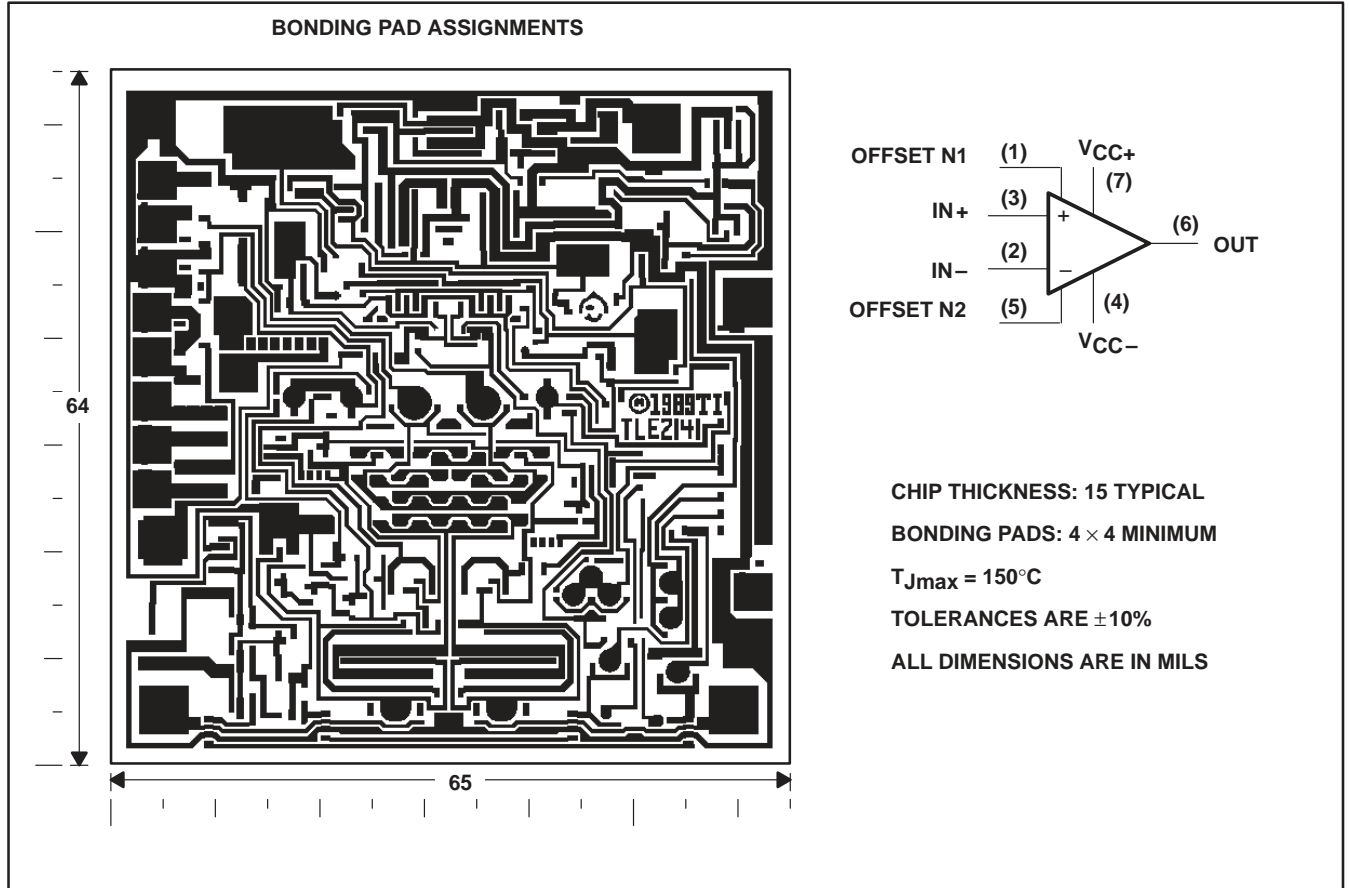
NC – No internal connection

TLE2141M, TLE2141AM EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

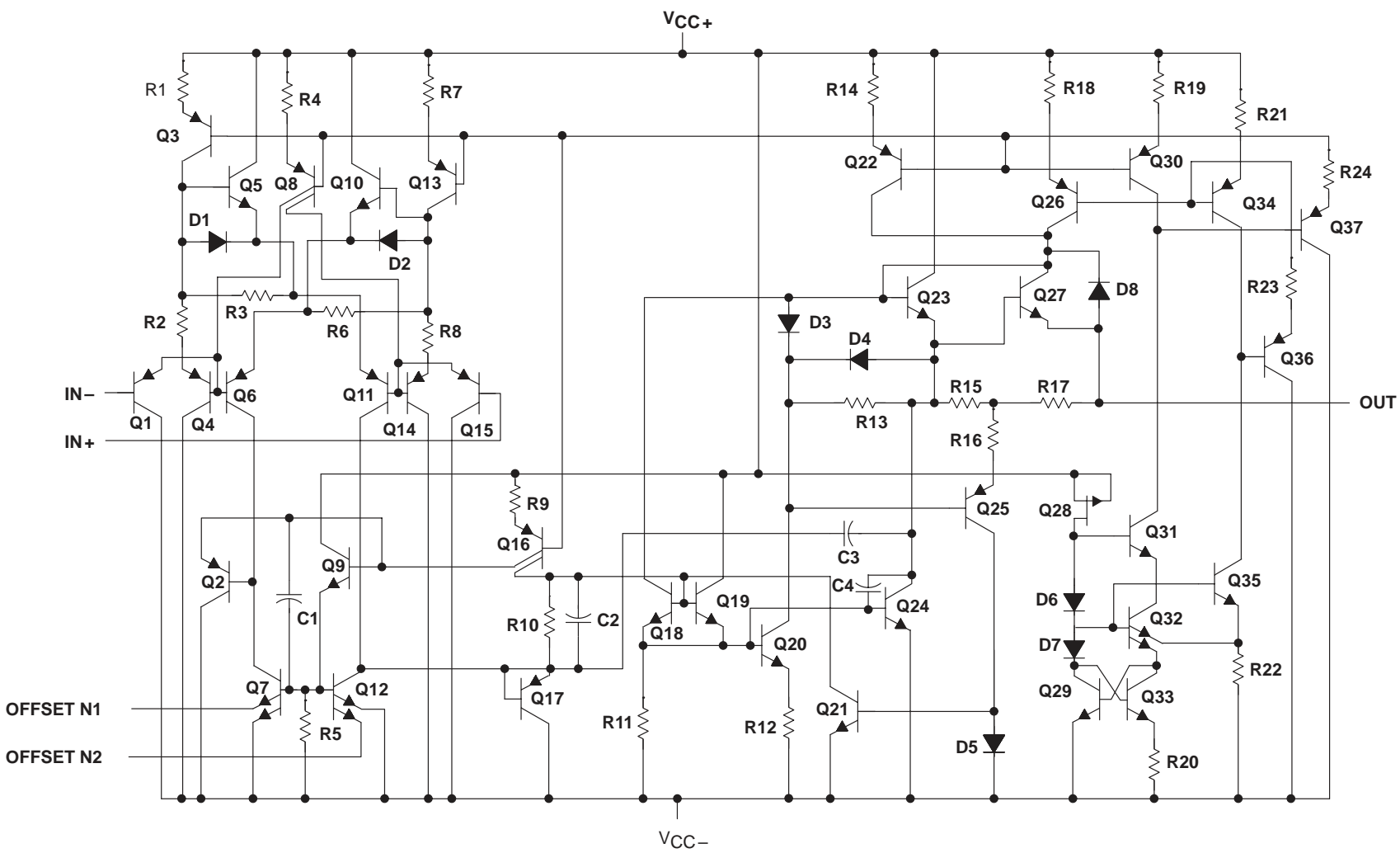
SGLS059 – NOVEMBER 1990 – REVISED OCTOBER 1991

chip information

These chips, when properly assembled, display characteristics similar to the TLE2141M. Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.



equivalent schematic



TLE2141M, TLE2141AM
EXCALIBUR LOW-NOISE HIGH-SPEED
PRECISION OPERATIONAL AMPLIFIERS

SGLS059 – NOVEMBER 1990 – REVISED OCTOBER 1991

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

Supply voltage, V_{CC+} (see Note 1)	22 V
Supply voltage, V_{CC-} (see Note 1)	-22 V
Differential input voltage (see Note 2)	± 44 V
Input voltage range, V_I (any input)	V_{CC+} to $V_{CC-} - 0.3$ V
Input current, I_I (each input)	± 1 mA
Output current, I_O	± 80 mA
Total current into V_{CC+}	80 mA
Total current out of V_{CC-}	80 mA
Duration of short-circuit current at (or below) 25°C (see Note 3)	unlimited
Continuous total dissipation	See Dissipation Rating Table
Operating free-air temperature range, T_A	-55°C to 125°C
Storage temperature range	-65°C to 150°C
Case temperature for 60 seconds: FK package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package	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. Excessive current will flow if input voltage is brought below $V_{CC-} - 0.3$ V.
3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 105^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
FK	1375 mW	11.0 mW/°C	880 mW	495 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	378 mW	210 mW

recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, $V_{CC\pm}$		± 2	± 22	V
Common-mode input voltage, V_{IC}	$V_{CC} = 5$ V	0	2.7	V
	$V_{CC\pm} = \pm 15$ V	-15	12.7	
Operating free-air temperature, T_A		-55	125	°C



TLE2141M, TLE2141AM
EXCALIBUR LOW-NOISE HIGH-SPEED
PRECISION OPERATIONAL AMPLIFIERS

SGLS059 – NOVEMBER 1990 – REVISED OCTOBER 1991

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

PARAMETER	TEST CONDITIONS	T_A †	TLE2141M			TLE2141AM			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage		25°C	225	1400		200	1000	μV	
		Full range			2100		1700		
α_{VIO} Temperature coefficient of input offset voltage	$V_O = 2.5\text{ V}$, $R_S = 50\ \Omega$, $V_{IC} = 2.5\text{ V}$	Full range	1.7			1.7			$\mu\text{V}/^\circ\text{C}$
I_{IO} Input offset current		25°C	8	100		8	100	nA	
		Full range	250			250			
I_{IB} Input bias current		25°C	-0.8	-2		-0.8	-2	μA	
		Full range	-2.3			-2.3			
V_{ICR} Common-mode input voltage range		$R_S = 50\ \Omega$	25°C	0 to 3	-0.3 to 3.2		0 to 3	-0.3 to 3.2	V
	Full range		0 to 2.7	-0.3 to 2.9		0 to 2.7	-0.3 to 2.9		
V_{OH} High-level output voltage	$I_{OH} = -150\ \mu\text{A}$	25°C	3.9	4.1		3.9	4.1	V	
	$I_{OH} = -1.5\text{ mA}$		3.8	4		3.8	4		
	$I_{OH} = -15\text{ mA}$		3.2	3.7		3.2	3.7		
	$I_{OH} = -100\ \mu\text{A}$	Full range	3.75			3.75			
	$I_{OH} = -1\text{ mA}$		3.65			3.65			
	$I_{OH} = -10\text{ mA}$		3.25			3.25			
V_{OL} Low-level output voltage	$I_{OL} = 150\ \mu\text{A}$	25°C	75	125		75	125	mV	
	$I_{OL} = 1.5\text{ mA}$		150	225		150	225		
	$I_{OL} = 15\text{ mA}$		1.2	1.4		1.2	1.4		
	$I_{OL} = 100\ \mu\text{A}$	Full range	200			200			
	$I_{OL} = 1\text{ mA}$		250			250			
	$I_{OL} = 10\text{ mA}$		1.25			1.25			
A_{VD} Large-signal differential voltage amplification	$V_{CC} = \pm 2.5\text{ V}$, $R_L = 2\text{ k}\Omega$, $V_O = 1\text{ V to } -1.5\text{ V}$	25°C	50	220		50	220	V/mV	
		Full range	5			5			
r_i Input resistance		25°C	70			70			M Ω
c_i Input capacitance		25°C	2.5			2.5			pF
z_o Open-loop output impedance	$f = 1\text{ MHz}$	25°C	30			30			Ω
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR}\text{ min}$, $R_S = 50\ \Omega$	25°C	85	118		85	118	dB	
		Full range	80			80			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm 2.5\text{ V to } \pm 15\text{ V}$, $R_S = 50\ \Omega$	25°C	90	106		90	106	dB	
		Full range	85			85			
I_{CC} Supply current	$V_O = 2.5\text{ V}$, No load, $V_{IC} = 2.5\text{ V}$	25°C	3.4	4.4		3.4	4.4	mA	
		Full range	4.6			4.6			

† Full range is -55°C to 125°C .



TLE2141M, TLE2141AM
EXCALIBUR LOW-NOISE HIGH-SPEED
PRECISION OPERATIONAL AMPLIFIERS

SGLS059 – NOVEMBER 1990 – REVISED OCTOBER 1991

operating characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLE2141M			TLE2141AM			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	$A_{VD} = -1$, $C_L = 500\text{ pF}$		$R_L = 2\text{ k}\Omega^\dagger$		45		V/ μs
SR-	Negative slew rate					42		
	Settling time	$A_{VD} = -1$, 2.5-V step	To 0.1%		0.16		μs	
			To 0.01%		0.22			
V_n	Equivalent input noise voltage	$R_S = 100\ \Omega$, $f = 10\text{ Hz}$		15		nV/ $\sqrt{\text{Hz}}$		
		$R_S = 100\ \Omega$, $f = 1\text{ kHz}$		10.5				
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$		0.48		μV		
		$f = 0.1\text{ Hz to }10\text{ Hz}$		0.51				
I_n	Equivalent input noise current	$f = 10\text{ Hz}$		1.92		pA/ $\sqrt{\text{Hz}}$		
		$f = 1\text{ kHz}$		0.5				
THD + N	Total harmonic distortion plus noise	$V_O = 1\text{ V to }3\text{ V}$, $A_{VD} = 2$		$R_L = 2\text{ k}\Omega^\dagger$, $f = 10\text{ kHz}$		0.0052%		
B1	Unity-gain bandwidth	$R_L = 2\text{ k}\Omega^\dagger$, $C_L = 100\text{ pF}$		5.9		MHz		
	Gain-bandwidth product	$R_L = 2\text{ k}\Omega^\dagger$, $f = 100\text{ kHz}$		5.8		MHz		
B_{OM}	Maximum output-swing bandwidth	$R_L = 2\text{ k}\Omega^\dagger$, $A_{VD} = 1$		$V_{O(PP)} = 2\text{ V}$		6.6 MHz		
ϕ_m	Phase margin at unity gain	$R_L = 2\text{ k}\Omega^\dagger$, $C_L = 100\text{ pF}$		57°		57°		

$^\dagger R_L$ terminates at 2.5 V.

TLE2141M, TLE2141AM
EXCALIBUR LOW-NOISE HIGH-SPEED
PRECISION OPERATIONAL AMPLIFIERS

SGLS059 – NOVEMBER 1990 – REVISED OCTOBER 1991

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

PARAMETER	TEST CONDITIONS	T_A †	TLE2141M			TLE2141AM			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, R_S = 50 \Omega$	25°C	200		900	175		500	μ V
		Full range	1700			1200			
α_{VIO} Temperature coefficient of input offset voltage		Full range	1.7			1.7			μ V/°C
I_{IO} Input offset current		25°C	7		100	7		100	nA
		Full range	250			250			
I_{IB} Input bias current		25°C	-0.7		-1.5	-0.7		-1.5	μ A
	Full range	-1.8			-1.8				
V_{ICR} Common-mode input voltage range	$R_S = 50 \Omega$	25°C	-15 to 13	-15.3 to 13.2		-15 to 13	-15.3 to 13.2	V	
		Full range	-15 to 12.7	-15.3 to 12.9		-15 to 12.7	-15.3 to 12.9		
V_{OM+} Maximum positive peak output voltage swing	$I_O = -150 \mu$ A	25°C	13.8	14.1		13.8	14.1	V	
	$I_O = -1.5$ mA		13.7	14		13.7	14		
	$I_O = -15$ mA		13.1	13.7		13.1	13.7		
	$I_O = -100 \mu$ A	Full range	13.7			13.7			
	$I_O = -1$ mA		13.6			13.6			
	$I_O = -10$ mA		13.1			13.1			
V_{OM-} Maximum negative peak output voltage swing	$I_O = 150 \mu$ A	25°C	-14.7	-14.9		-14.7	-14.9	V	
	$I_O = 1.5$ mA		-14.5	-14.8		-14.5	-14.8		
	$I_O = 15$ mA		-13.4	-13.8		-13.4	-13.8		
	$I_O = 100 \mu$ A	Full range	-14.6			-14.6			
	$I_O = 1$ mA		-14.5			-14.5			
	$I_O = 10$ mA		-13.4			-13.4			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 10$ V, $R_L = 2$ k Ω	25°C	100	450		100	450	V/mV	
		Full range	20			20			
r_i Input resistance		25°C	65			65			M Ω
c_i Input capacitance		25°C	2.5			2.5			pF
z_o Open-loop output impedance	$f = 1$ MHz	25°C	30			30			Ω
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR}$ min, $R_S = 50 \Omega$	25°C	85	108		85	108	dB	
		Full range	80			80			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{CC\pm} / \Delta V_{IO}$)	$V_{CC\pm} = \pm 2.5$ V to ± 15 V, $R_S = 50 \Omega$	25°C	90	106		90	106	dB	
		Full range	85			85			
I_{OS} Short-circuit output current	$V_O = 0$	25°C	$V_{ID} = 1$ V	-25	-50	-25	-50	mA	
			$V_{ID} = -1$ V	20	31	20	31		
I_{CC} Supply current	$V_O = 0, V_{IC} = 2.5$ V	25°C	3.5		4.5	3.5		mA	
			4.7			4.7			

† Full range is -55°C to 125°C.



TLE2141M, TLE2141AM
EXCALIBUR LOW-NOISE HIGH-SPEED
PRECISION OPERATIONAL AMPLIFIERS

SGLS059 – NOVEMBER 1990 – REVISED OCTOBER 1991

operating characteristics, $V_{CC\pm} = \pm 15$, $T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS		TLE2141M			TLE2141AM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	$A_{VD} = -1$, $C_L = 500\text{ pF}$ $R_L = 2\text{ k}\Omega$,		30	45		30	45		V/ μs
SR-	Negative slew rate			30	42		30	42		
Settling time		$A_{VD} = -1$, 10-V step		To 0.1%			0.34			μs
				To 0.01%			0.4			
V_n	Equivalent input noise voltage	$R_S = 100\ \Omega$, $f = 10\text{ Hz}$				15	15			nV/ $\sqrt{\text{Hz}}$
		$R_S = 100\ \Omega$, $f = 1\text{ kHz}$				10.5	10.5			
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$				0.48	0.48			μV
		$f = 0.1\text{ Hz to }10\text{ Hz}$				0.51	0.51			
I_n	Equivalent input noise current	$f = 10\text{ Hz}$				1.89	1.89			pA/ $\sqrt{\text{Hz}}$
		$f = 1\text{ kHz}$				0.47	0.47			
THD + N	Total harmonic distortion plus noise	$V_{O(PP)} = 20\text{ V}$, $A_{VD} = 10$, $R_L = 2\text{ k}\Omega$, $f = 10\text{ kHz}$				0.01%	0.01%			
B_1	Unity-gain bandwidth	$R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$				6	6		MHz	
	Gain-bandwidth product	$R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $f = 100\text{ kHz}$				5.9	5.9		MHz	
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 20\text{ V}$, $A_{VD} = 1$, $R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$				668	668		kHz	
ϕ_m	Phase margin at unity gain	$R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$				58°	58°			

TLE2141Y
EXCALIBUR LOW-NOISE HIGH-SPEED
PRECISION OPERATIONAL AMPLIFIER

SGLS059 – NOVEMBER 1990 – REVISED OCTOBER 1991

electrical characteristics, $V_{CC\pm} = \pm 15\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	$V_{IC} = 0$, $R_S = 50\ \Omega$, $V_O = 0$		200	1000	μV
I_{IO}	Input offset current			7	100	nA
I_{IB}	Input bias current			-0.7	-1.5	μA
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$	-15 to 13	-15.3 to 13.2		V
V_{OM+}	Maximum positive peak output voltage swing	$I_O = -150\ \mu\text{A}$	13.8	14.1		V
		$I_O = -1.5\ \text{mA}$	13.7	14		
		$I_O = -15\ \text{mA}$	13.3	13.7		
V_{OM-}	Maximum negative peak output voltage swing	$I_O = 150\ \mu\text{A}$	-14.7	-14.9		V
		$I_O = 1.5\ \text{mA}$	-14.5	-14.8		
		$I_O = 15\ \text{mA}$	-13.4	-13.8		
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm 10\ \text{V}$, $R_L = 2\ \text{k}\Omega$	100	450		V/mV
r_i	Input resistance			65		M Ω
c_i	Input capacitance			2.5		pF
z_o	Open-loop output impedance	$f = 1\ \text{MHz}$		30		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR\ \text{min}}$, $R_S = 50\ \Omega$	80	108		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm} / \Delta V_{IO}$)	$V_{CC\pm} = \pm 2.5\ \text{V}$ to $\pm 15\ \text{V}$, $R_S = 50\ \Omega$	85	106		dB
I_{OS}	Short-circuit output current	$V_O = 0$	$V_{ID} = 1\ \text{V}$	-25	-50	mA
			$V_{ID} = -1\ \text{V}$	20	31	
I_{CC}	Supply current	$V_O = 0$, No load		3.5	4.5	mA

TYPICAL CHARACTERISTICS

Table of Graphs

		FIGURE	
V_{IO}	Input offset voltage	Distribution	1
I_{IO}	Input offset current	vs Temperature	2
I_{IB}	Input bias current	vs Temperature	3
		vs Common-mode input voltage	4
V_{OM+}	Maximum positive peak output voltage	vs Supply voltage	5
		vs Temperature	6
		vs Output current	7
		vs Setting time	9
V_{OM-}	Maximum negative peak output voltage	vs Supply voltage	5
		vs Temperature	6
		vs Output current	8
		vs Setting time	9
$V_{O(PP)}$	Maximum peak-to-peak output voltage swing	vs Frequency	10
V_{OH}	High-level output voltage	vs Output current	11
V_{OL}	Low-level output voltage	vs Output current	12
A_{VD}	Differential voltage amplification	vs Temperature	13
		vs Frequency	14
z_o	Closed loop output impedance	vs Frequency	15
I_{OS}	Short-circuit output current	vs Supply current	16
CMRR	Common-mode rejection ratio	vs Supply current	17
		vs Temperature	18
k_{SVR}	Supply-voltage rejection ratio	vs Frequency	19
		vs Temperature	20
I_{CC}	Supply current	vs Temperature	21
		vs Supply voltage	22
V_n	Equivalent input noise voltage	vs Frequency	23
$V_{N(PP)}$	Equivalent input noise voltage	Over a 10-second period	24
I_n	Noise current	vs Frequency	25
THD+N	Total harmonic distortion plus noise	vs Frequency	26
SR	Slew rate	vs Temperature	27
		vs Load capacitance	28
Pulse response	Noninverting large signal	vs Time	29
	Inverting large signal	vs Time	30
	Small signal	vs Time	31
B_1	Unity-gain-bandwidth	vs Load capacitance	32
	Gain margin	vs Load capacitance	33
ϕ_m	Phase margin	vs Load capacitance	34
	Phase shift	vs Frequency	14

TLE2141M, TLE2141AM
EXCALIBUR LOW-NOISE HIGH-SPEED
PRECISION OPERATIONAL AMPLIFIERS

SGLS059 – NOVEMBER 1990 – REVISED OCTOBER 1991

TYPICAL CHARACTERISTICS

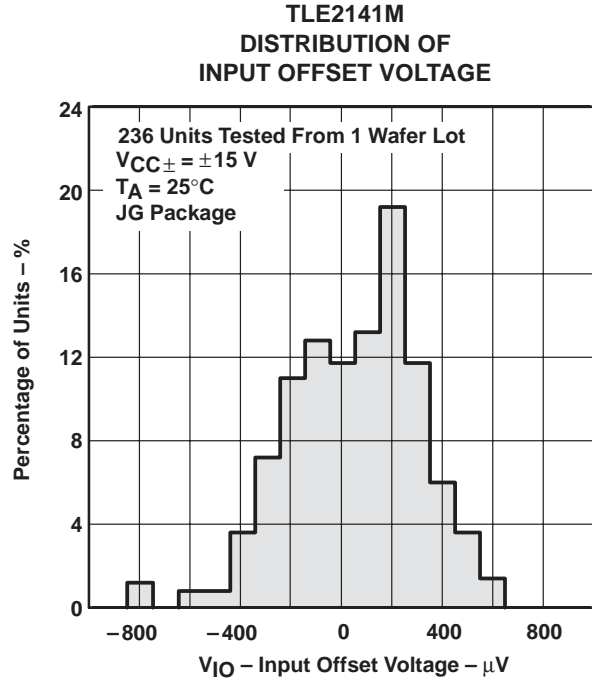


Figure 1

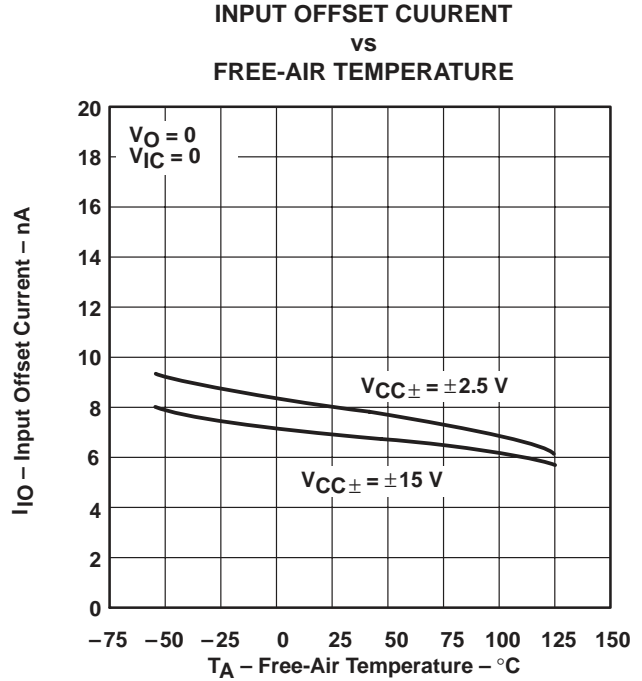


Figure 2

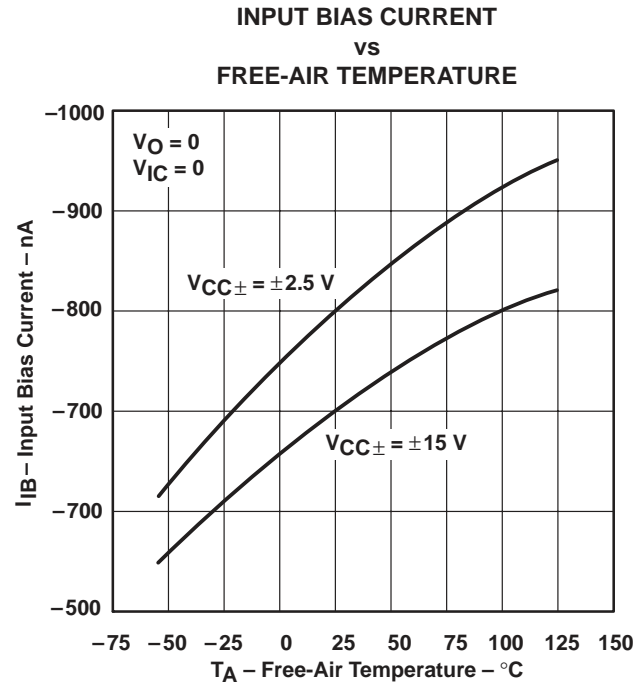


Figure 3

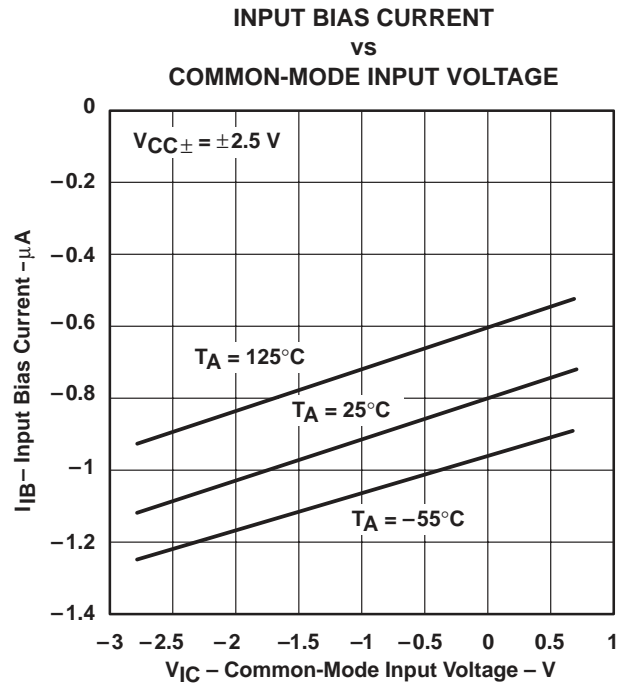


Figure 4

TYPICAL CHARACTERISTICS

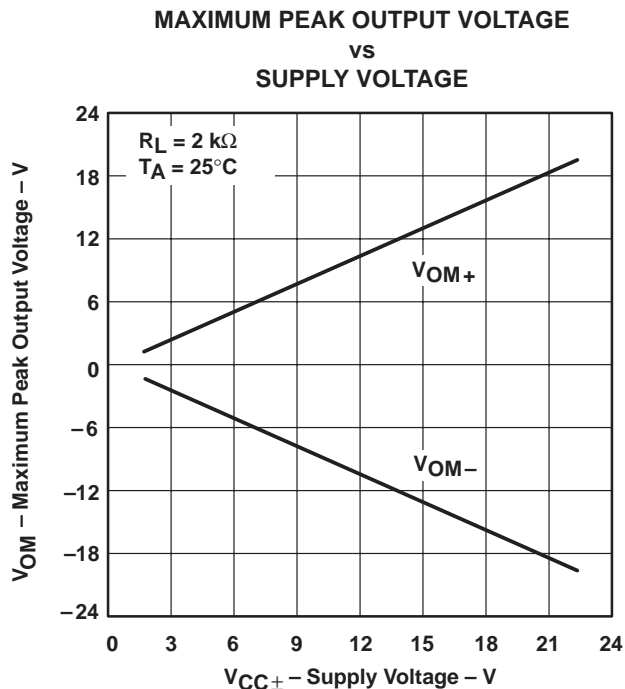


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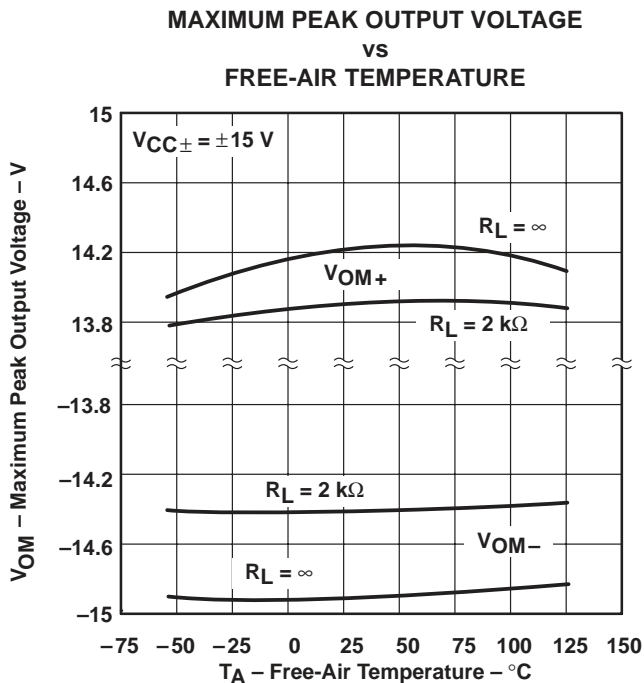


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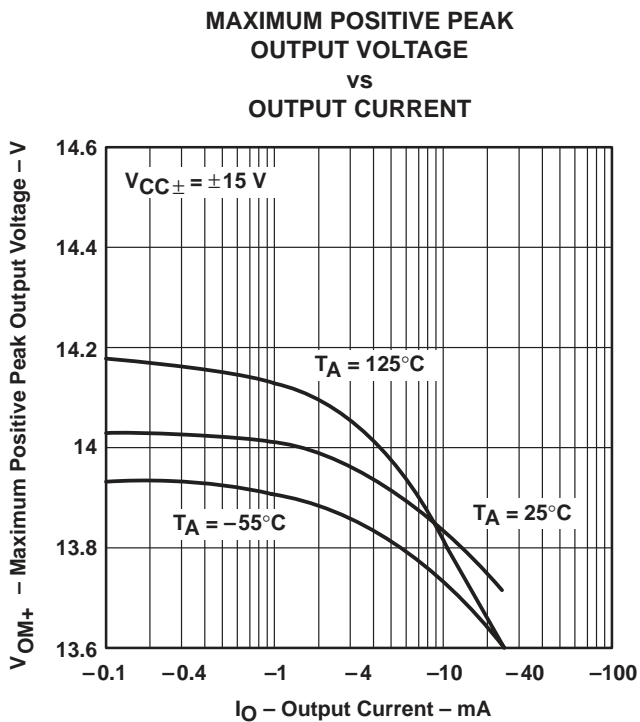


Figure 7

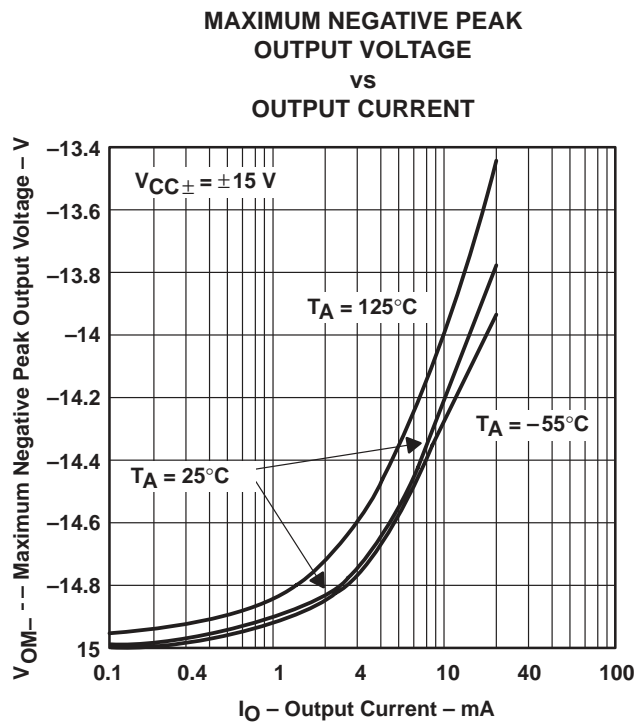


Figure 8

TLE2141M, TLE2141AM
EXCALIBUR LOW-NOISE HIGH-SPEED
PRECISION OPERATIONAL AMPLIFIERS

SGLS059 – NOVEMBER 1990 – REVISED OCTOBER 1991

TYPICAL CHARACTERISTICS

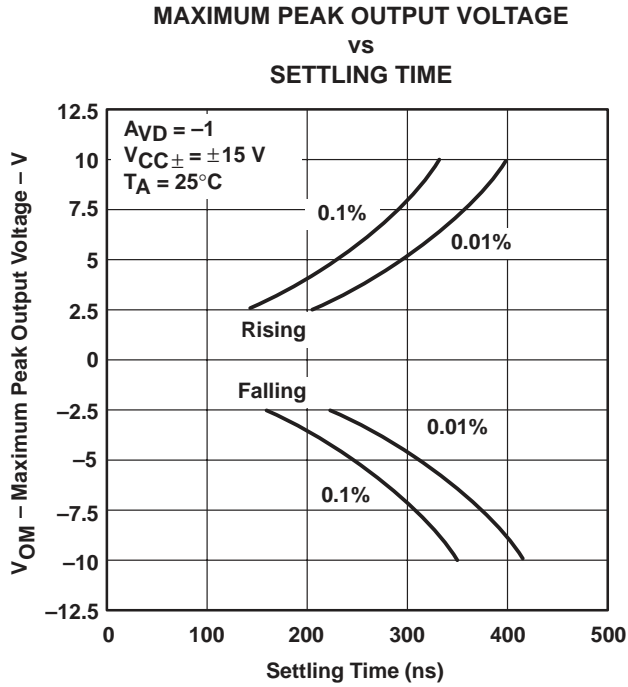


Figure 9

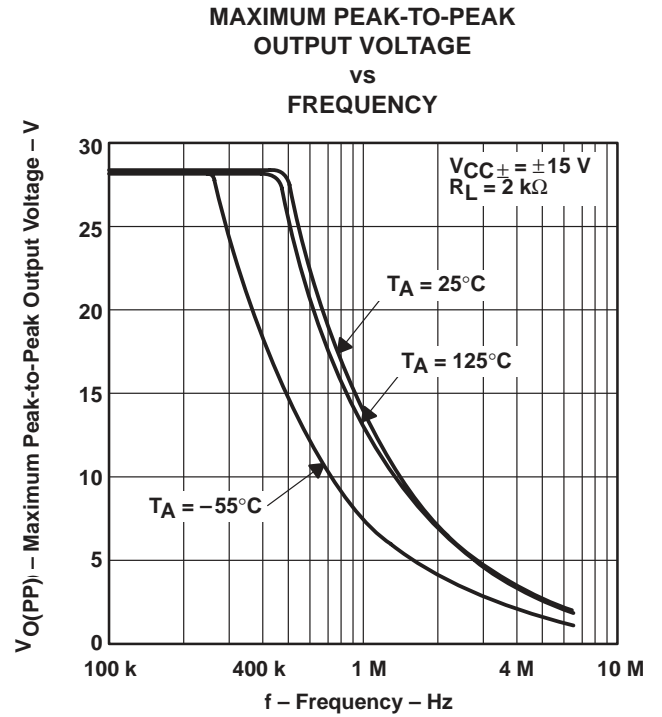


Figure 10

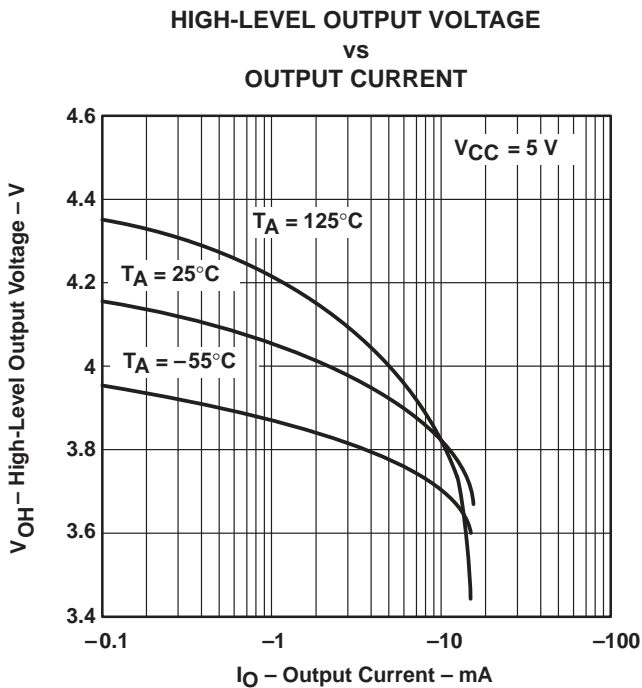


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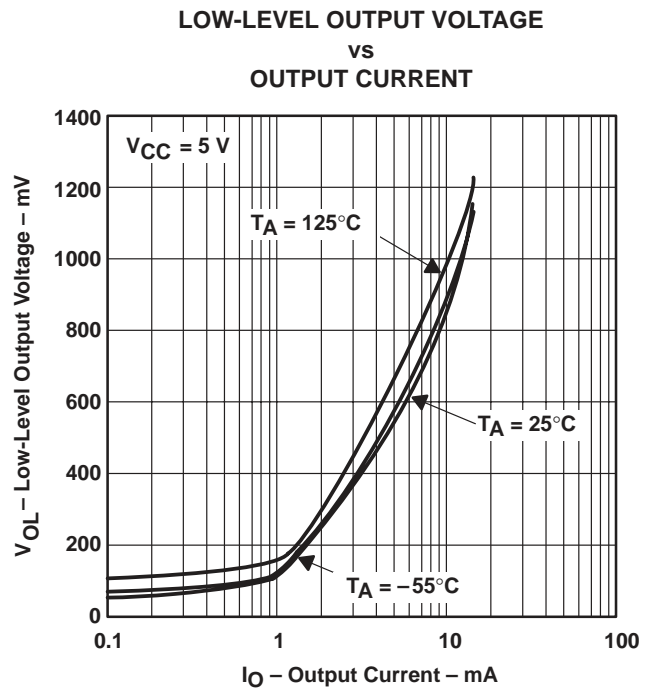


Figure 12



TYPICAL CHARACTERISTICS

LARGE-SIGNAL DIFFERENTIAL
 VOLTAGE AMPLIFICATION
 VS
 FREE-AIR TEMPERATURE

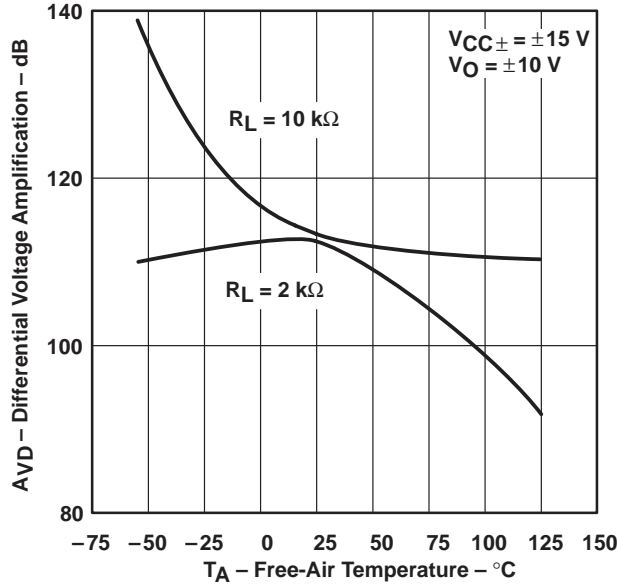


Figure 13

LARGE-SIGNAL DIFFERENTIAL VOLTAGE
 AMPLIFICATION AND PHASE SHIFT
 VS
 FREQUENCY

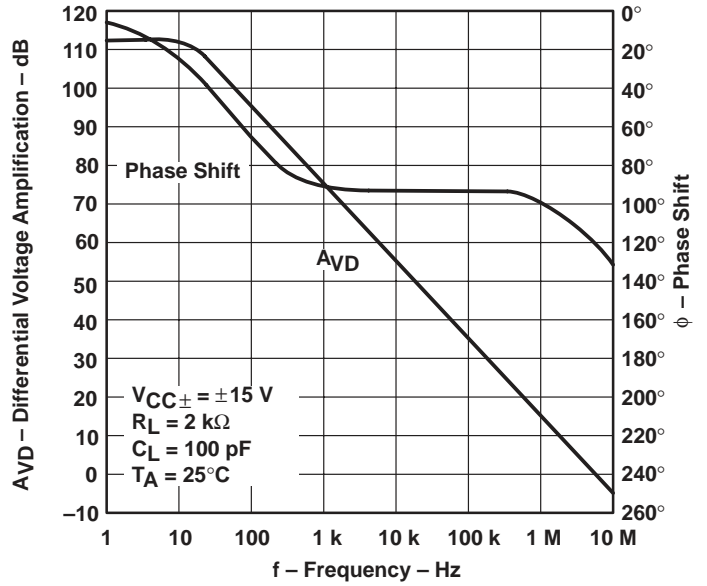


Figure 14

CLOSED-LOOP OUTPUT IMPEDANCE
 VS
 FREQUENCY

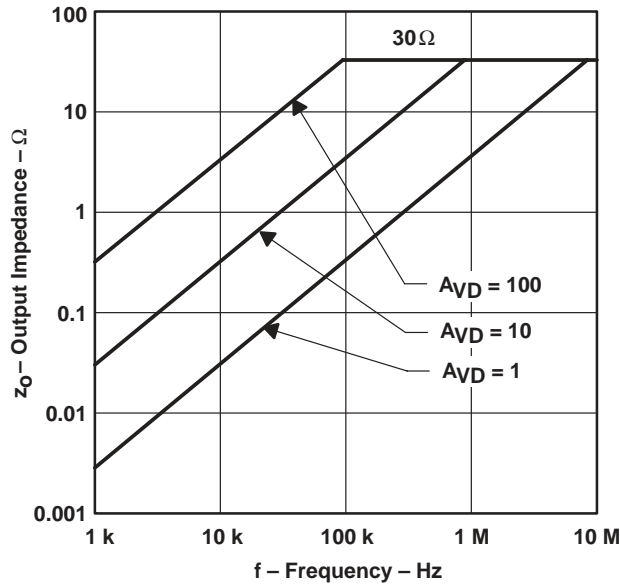


Figure 15

SHORT-CIRCUIT OUTPUT CURRENT
 VS
 FREE-AIR TEMPERATURE

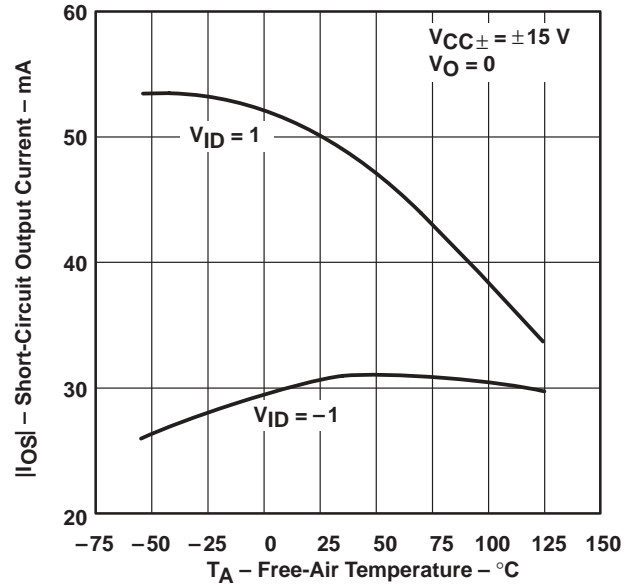


Figure 16

TYPICAL CHARACTERISTICS

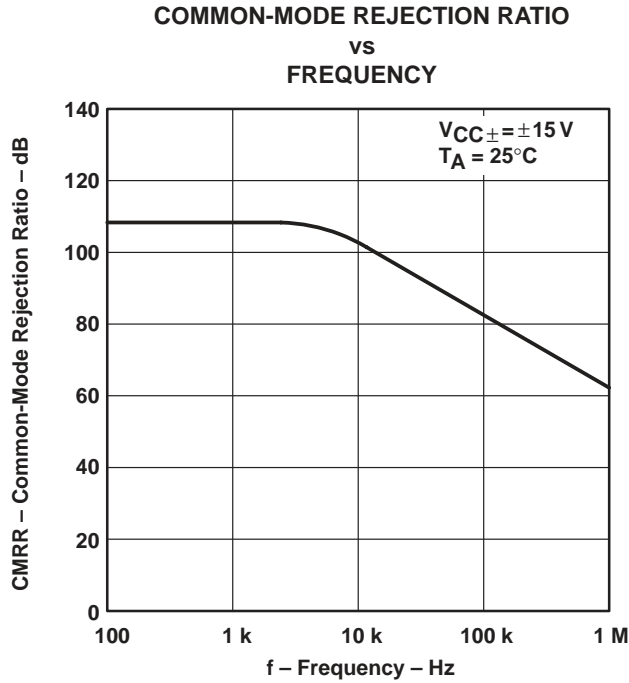


Figure 17

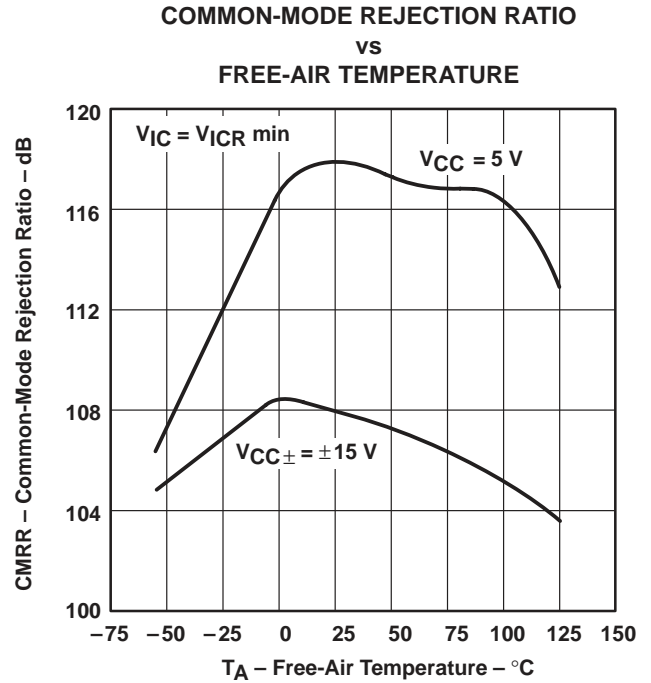


Figure 18

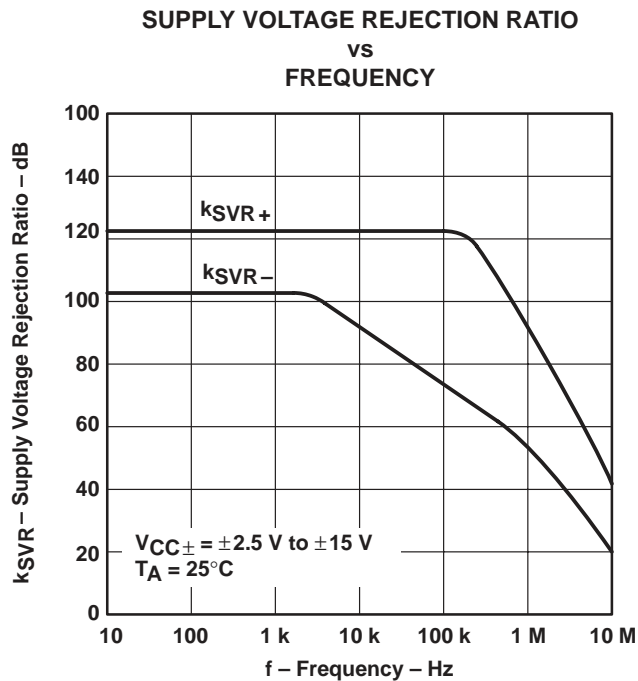


Figure 19

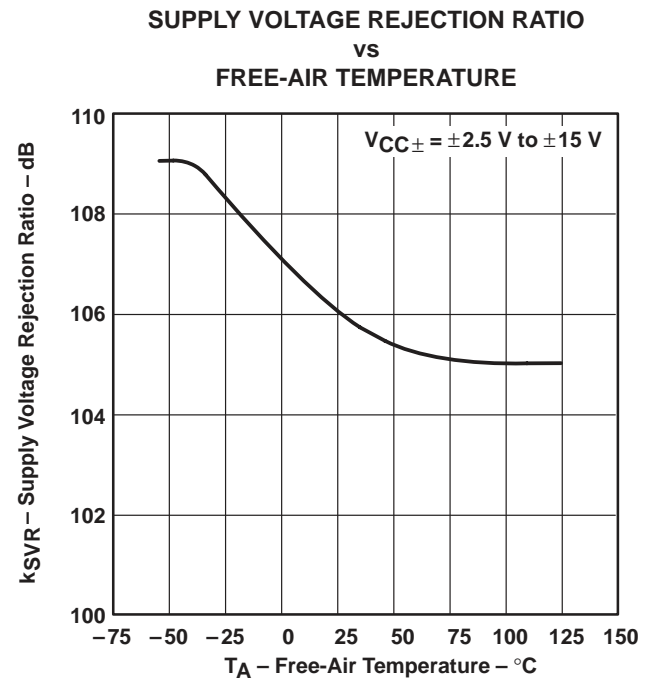


Figure 20

TYPICAL CHARACTERISTICS

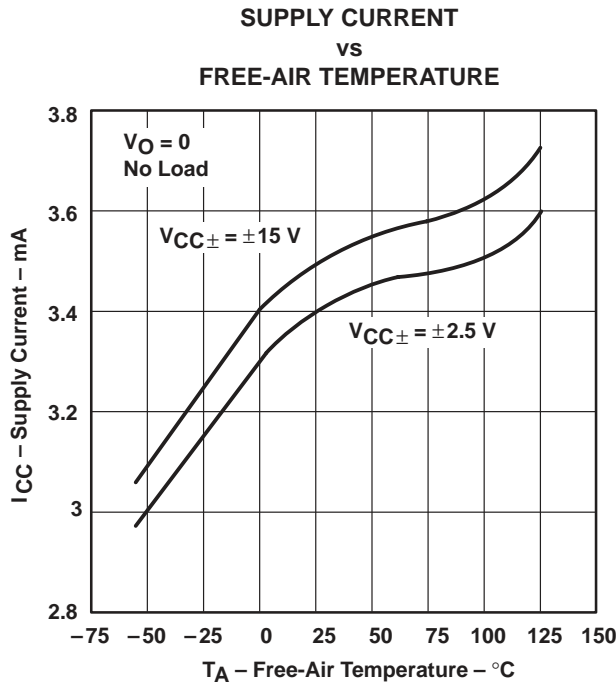


Figure 21

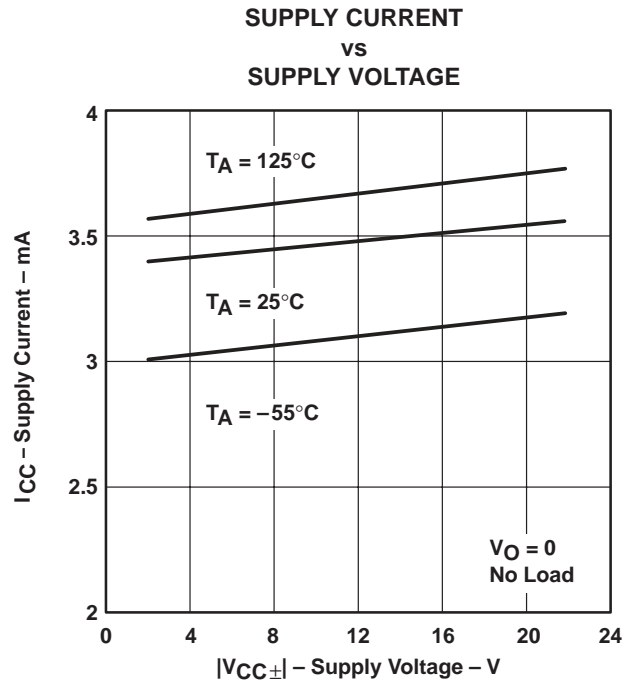


Figure 22

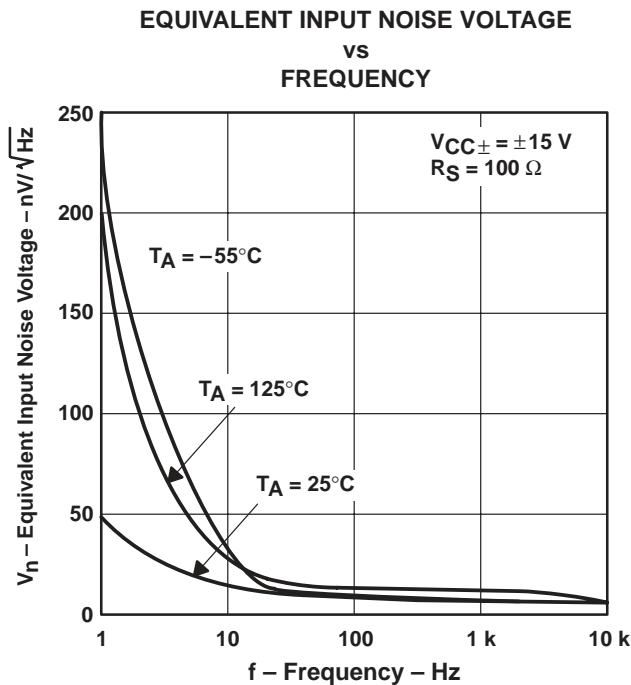


Figure 23

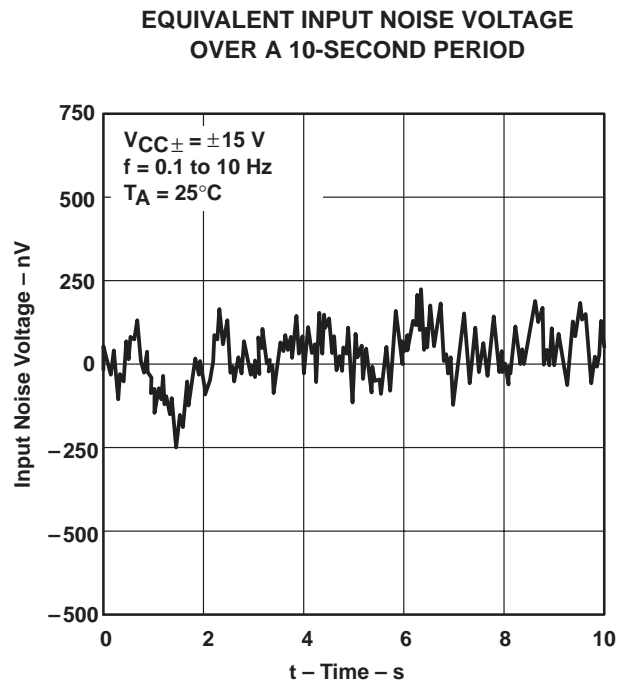
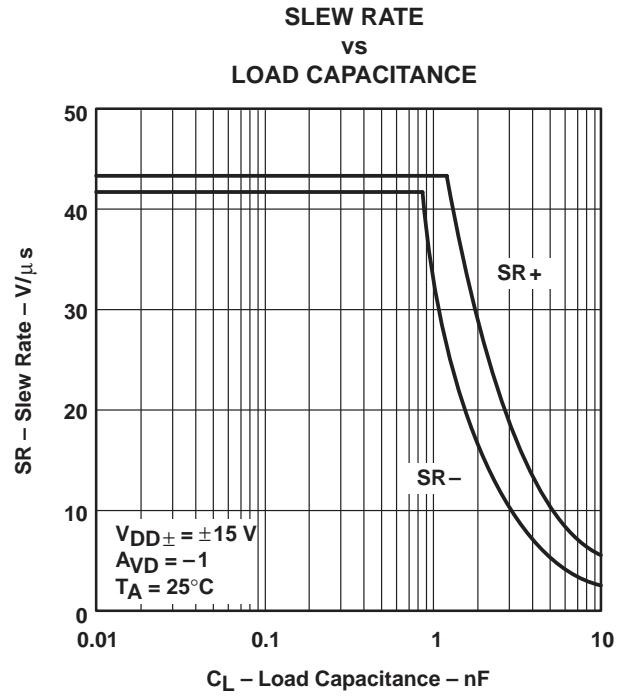
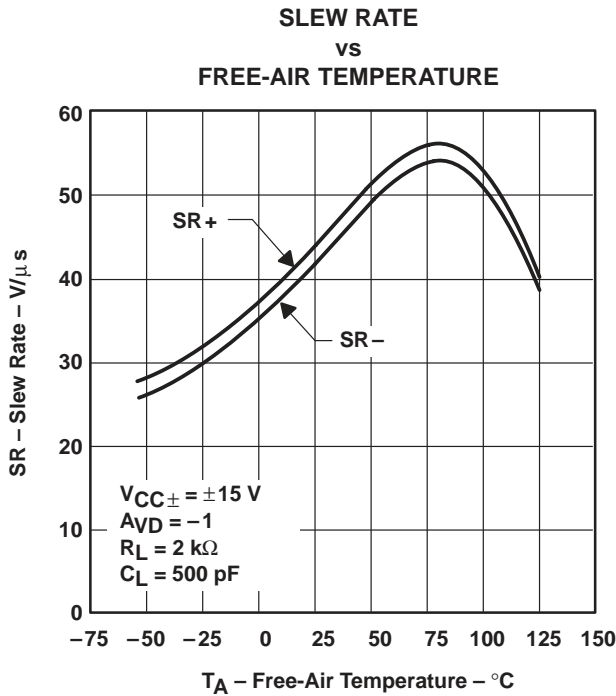
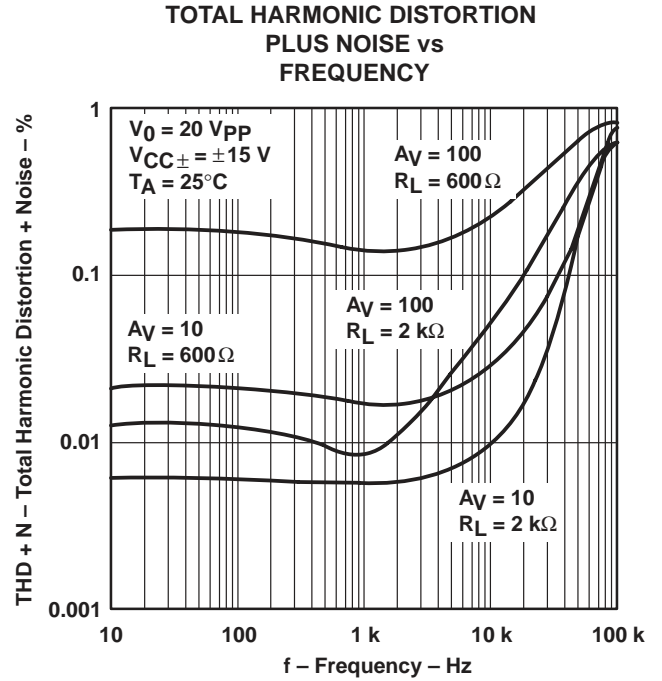
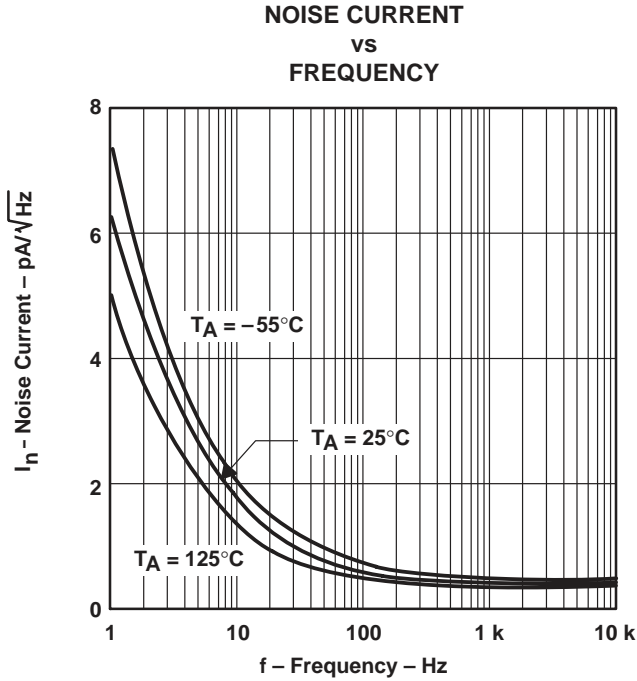
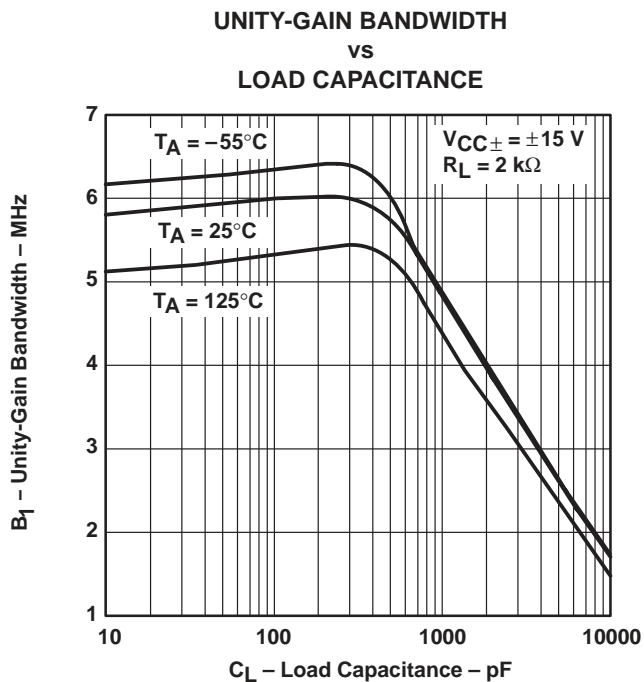
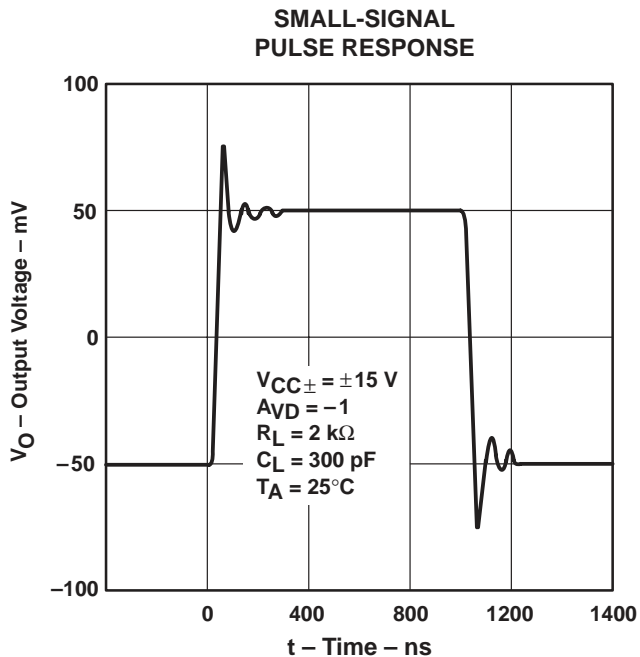
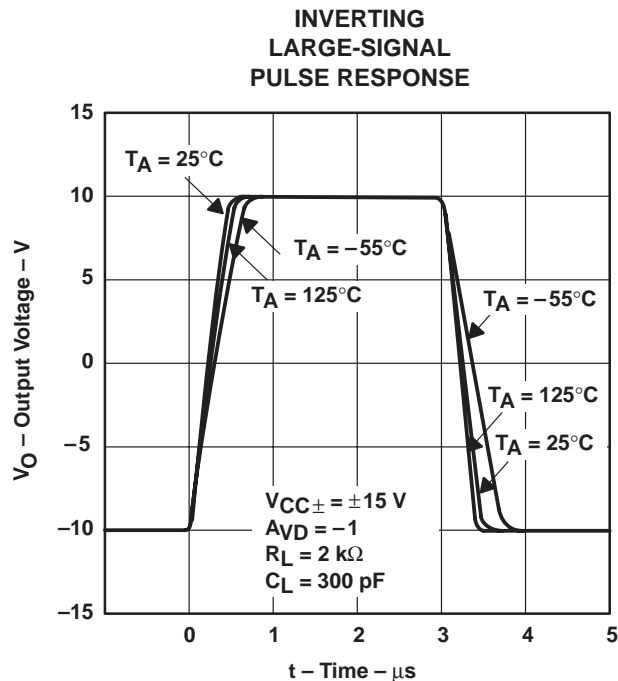
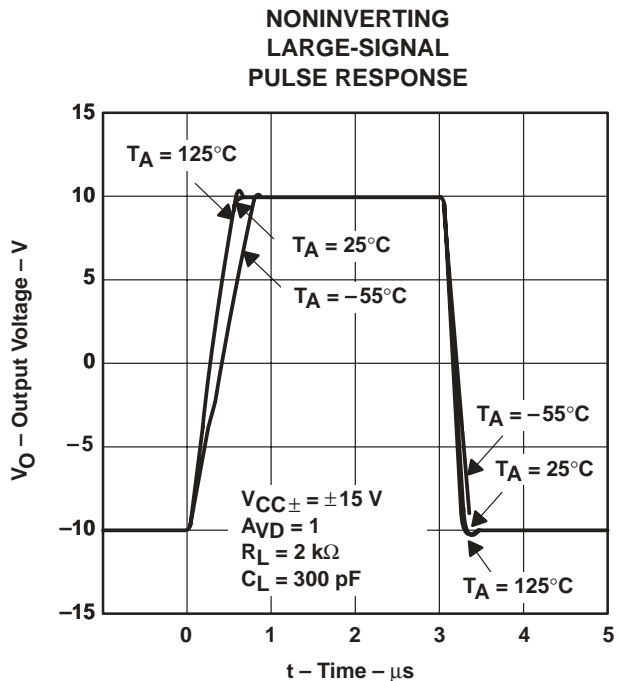


Figure 24

TYPICAL CHARACTERISTICS



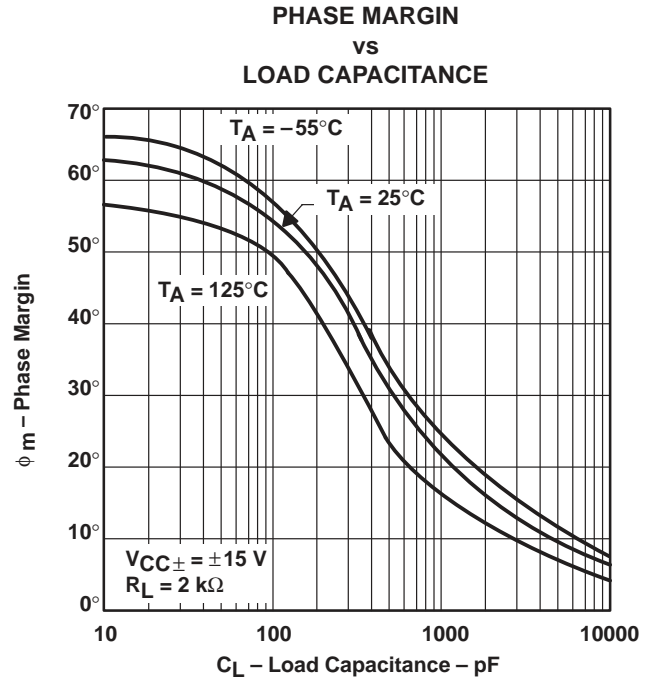
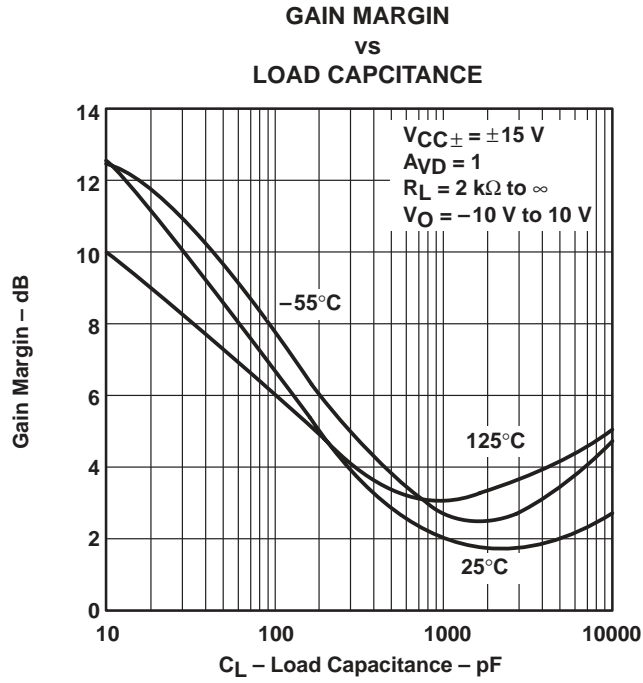
TYPICAL CHARACTERISTICS



TLE2141M, TLE2141AM
EXCALIBUR LOW-NOISE HIGH-SPEED
PRECISION OPERATIONAL AMPLIFIERS

SGLS059 – NOVEMBER 1990 – REVISED OCTOBER 1991

TYPICAL CHARACTERISTICS



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