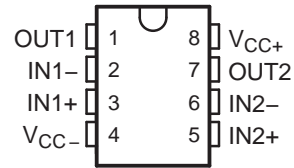


## FEATURES

- Dual-Supply Operation . . .  $\pm 5\text{ V}$  to  $\pm 18\text{ V}$
- Low Noise Voltage . . .  $4.5\text{ nV}/\sqrt{\text{Hz}}$
- Low Input Offset Voltage . . .  $0.15\text{ mV}$
- Low Total Harmonic Distortion . . .  $0.002\%$
- High Slew Rate . . .  $7\text{ V}/\mu\text{s}$
- High-Gain Bandwidth Product . . .  $16\text{ MHz}$
- High Open-Loop AC Gain . . .  $800$  at  $20\text{ kHz}$
- Large Output-Voltage Swing . . .  $14.1\text{ V}$  to  $-14.6\text{ V}$
- Excellent Gain and Phase Margins

D (SOIC), DGK (MSOP), OR P (PDIP) PACKAGE  
(TOP VIEW)



## DESCRIPTION/ORDERING INFORMATION

The MC33078 is a bipolar dual operational amplifier with high-performance specifications for use in quality audio and data-signal applications. This device operates over a wide range of single- and dual-supply voltages and offers low noise, high-gain bandwidth, and high slew rate. Additional features include low total harmonic distortion, excellent phase and gain margins, large output voltage swing with no deadband crossover distortion, and symmetrical sink/source performance.

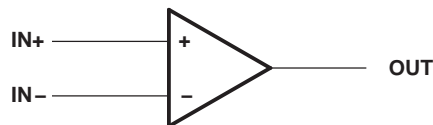
### ORDERING INFORMATION

$T_A$	PACKAGE <sup>(1)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING <sup>(2)</sup>
-40°C to 85°C	PDIP – P	Tube of 50	MC33078P	MC33078P
	SOIC – D	Tube of 75	MC33078D	M33078
		Reel of 2500	MC33078DR	
	VSSOP/MSOP – DGK	Reel of 2500	MC33078DGKR	MY_
		Reel of 250	MC33078DGKT	

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

(2) DGK: The actual top-side marking has one additional character that designates the assembly/test site.

### SYMBOL (EACH AMPLIFIER)



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.

### Absolute Maximum Ratings<sup>(1)</sup>

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

		MIN	MAX	UNIT
V <sub>CC+</sub>	Supply voltage <sup>(2)</sup>		18	V
V <sub>CC-</sub>	Supply voltage <sup>(2)</sup>		-18	V
V <sub>CC+</sub> - V <sub>CC-</sub>	Supply voltage		36	V
	Input voltage, either input <sup>(2)(3)</sup>		V <sub>CC+</sub> or V <sub>CC-</sub>	V
	Input current <sup>(4)</sup>		±10	mA
	Duration of output short circuit <sup>(5)</sup>		Unlimited	
θ <sub>JA</sub>	Package thermal impedance, junction to free air <sup>(6)(7)</sup>	D package	97	°C/W
		DGK package	172	
		P package	85	
T <sub>J</sub>	Operating virtual junction temperature		150	°C
T <sub>stg</sub>	Storage temperature range	-65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values, except differential voltages, are with respect to the midpoint between V<sub>CC+</sub> and V<sub>CC-</sub>.
- (3) The magnitude of the input voltage must never exceed the magnitude of the supply voltage.
- (4) Excessive input current will flow if a differential input voltage in excess of approximately 0.6 V is applied between the inputs, unless some limiting resistance is used.
- (5) The output may be shorted to ground or either power supply. Temperature and/or supply voltages must be limited to ensure the maximum dissipation rating is not exceeded.
- (6) Maximum power dissipation is a function of T<sub>J(max)</sub>, θ<sub>JA</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any allowable ambient temperature is P<sub>D</sub> = (T<sub>J(max)</sub> - T<sub>A</sub>)/θ<sub>JA</sub>. Operating at the absolute maximum T<sub>J</sub> of 150°C can affect reliability.
- (7) The package thermal impedance is calculated in accordance with JESD 51-7.

### Recommended Operating Conditions

		MIN	MAX	UNIT
V <sub>CC-</sub>	Supply voltage	-5	-18	V
V <sub>CC+</sub>		5	18	
T <sub>A</sub>	Operating free-air temperature range	-40	85	°C

### Electrical Characteristics

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

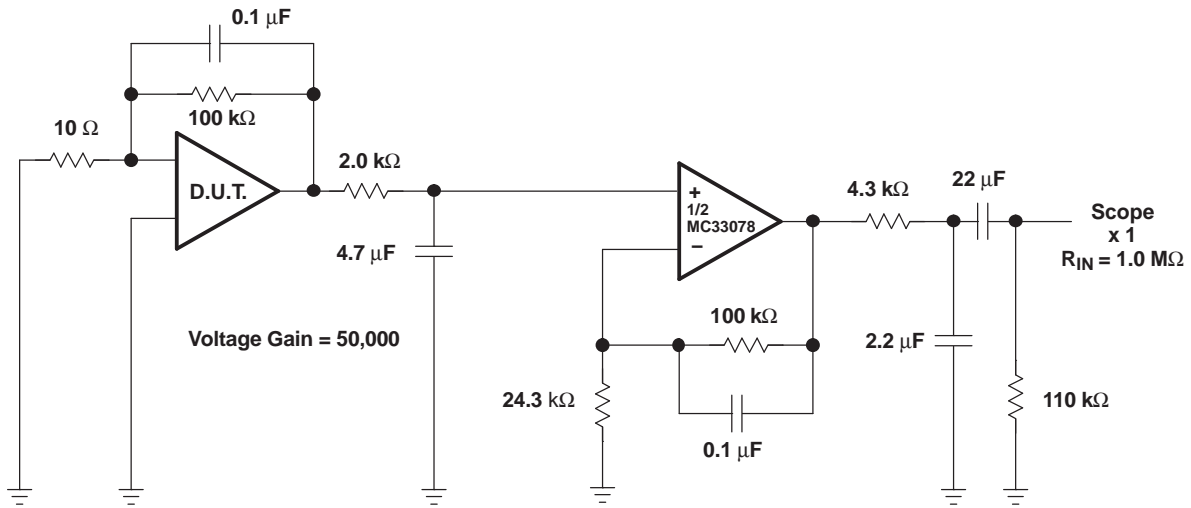
PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{IO}$	Input offset voltage	$V_O = 0$ , $R_S = 10\ \Omega$ , $V_{CM} = 0$	$T_A = 25^\circ\text{C}$	0.15	2	3	mV
			$T_A = -40^\circ\text{C}$ to $85^\circ\text{C}$				
$\alpha V_{IO}$	Input offset voltage temperature coefficient	$V_O = 0$ , $R_S = 10\ \Omega$ , $V_{CM} = 0$	$T_A = -40^\circ\text{C}$ to $85^\circ\text{C}$		2		$\mu\text{V}/^\circ\text{C}$
$I_{IB}$	Input bias current	$V_O = 0$ , $V_{CM} = 0$	$T_A = 25^\circ\text{C}$		300	750	nA
			$T_A = -40^\circ\text{C}$ to $85^\circ\text{C}$			800	
$I_{IO}$	Input offset current	$V_O = 0$ , $V_{CM} = 0$	$T_A = 25^\circ\text{C}$		25	150	nA
			$T_A = -40^\circ\text{C}$ to $85^\circ\text{C}$			175	
$V_{ICR}$	Common-mode input voltage range	$\Delta V_{IO} = 5\text{ mV}$ , $V_O = 0$		$\pm 13$	$\pm 14$		V
$A_{VD}$	Large-signal differential voltage amplification	$R_L \geq 2\text{ k}\Omega$ , $V_O = \pm 10\text{ V}$	$T_A = 25^\circ\text{C}$	90	110		dB
			$T_A = -40^\circ\text{C}$ to $85^\circ\text{C}$	85			
$V_{OM}$	Maximum output voltage swing	$V_{ID} = \pm 1\text{ V}$	$R_L = 600\ \Omega$	$V_{OM+}$	10.7		V
				$V_{OM-}$	-11.9		
			$R_L = 2\text{ k}\Omega$	$V_{OM+}$	13.2	13.8	
				$V_{OM-}$	-13.2	-13.7	
			$R_L = 10\text{ k}\Omega$	$V_{OM+}$	13.5	14.1	
				$V_{OM-}$	-14	-14.6	
CMMR	Common-mode rejection ratio	$V_{IN} = \pm 13\text{ V}$		80	100		dB
$k_{SVR}^{(1)}$	Supply-voltage rejection ratio	$V_{CC+} = 5\text{ V}$ to $15\text{ V}$ , $V_{CC-} = -5\text{ V}$ to $-15\text{ V}$		80	105		dB
$I_{OS}$	Output short-circuit current	$ V_{ID}  = 1\text{ V}$ , Output to GND	Source current	15	29		mA
			Sink current	-20	-37		
$I_{CC}$	Supply current (per channel)	$V_O = 0$	$T_A = 25^\circ\text{C}$		2.05	2.5	mA
			$T_A = -40^\circ\text{C}$ to $85^\circ\text{C}$			2.75	

(1) Measured with  $V_{CC\pm}$  differentially varied at the same time

### Operating Characteristics

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

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	$A_{VD} = 1$ , $V_{IN} = -10\text{ V}$ to $10\text{ V}$ , $R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$		5	7		V/ $\mu\text{s}$
GBW	Gain bandwidth product	$f = 100\text{ kHz}$		10	16		MHz
$B_1$	Unity gain frequency	Open loop			9		MHz
$G_m$	Gain margin	$R_L = 2\text{ k}\Omega$	$C_L = 0\text{ pF}$		-11		dB
			$C_L = 100\text{ pF}$		-6		
$\Phi_m$	Phase margin	$R_L = 2\text{ k}\Omega$	$C_L = 0\text{ pF}$		55		deg
			$C_L = 100\text{ pF}$		40		
	Amp-to-amp isolation	$f = 20\text{ Hz}$ to $20\text{ kHz}$			-120		dB
	Power bandwidth	$V_O = 27\text{ V}_{(PP)}$ , $R_L = 2\text{ k}\Omega$ , $\text{THD} \leq 1\%$			120		kHz
THD	Total harmonic distortion	$V_O = 3\text{ V}_{rms}$ , $A_{VD} = 1$ , $R_L = 2\text{ k}\Omega$ , $f = 20\text{ Hz}$ to $20\text{ kHz}$			0.002		%
$Z_o$	Open-loop output impedance	$V_O = 0$ , $f = 9\text{ MHz}$			37		$\Omega$
$r_{id}$	Differential input resistance	$V_{CM} = 0$			175		k $\Omega$
$C_{id}$	Differential input capacitance	$V_{CM} = 0$			12		pF
$V_n$	Equivalent input noise voltage	$f = 1\text{ kHz}$ , $R_S = 100\ \Omega$			4.5		nV/ $\sqrt{\text{Hz}}$
$I_n$	Equivalent input noise current	$f = 1\text{ kHz}$			0.5		pA/ $\sqrt{\text{Hz}}$



NOTE: All capacitors are non-polarized.

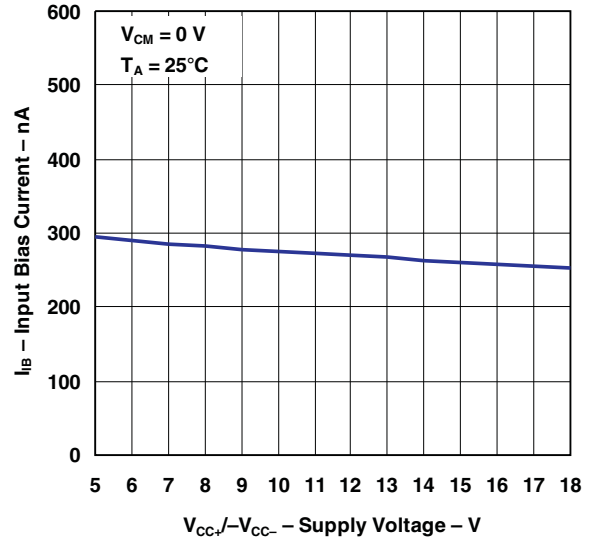
**Figure 1. Voltage Noise Test Circuit (0.1 Hz to 10 Hz)**

**TYPICAL CHARACTERISTICS**

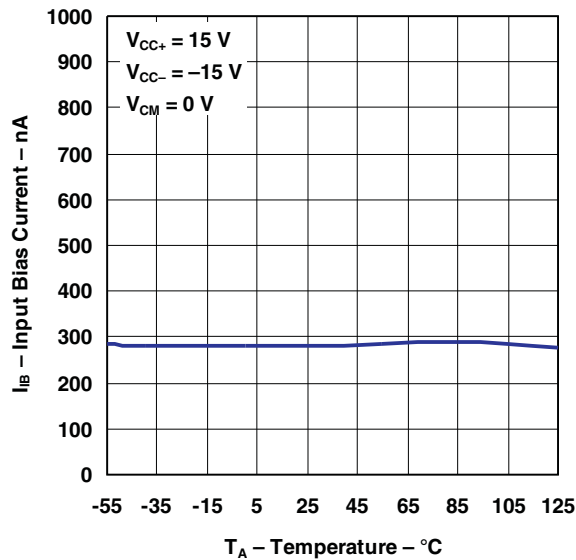
**INPUT BIAS CURRENT**  
 VS  
**COMMON-MODE VOLTAGE**



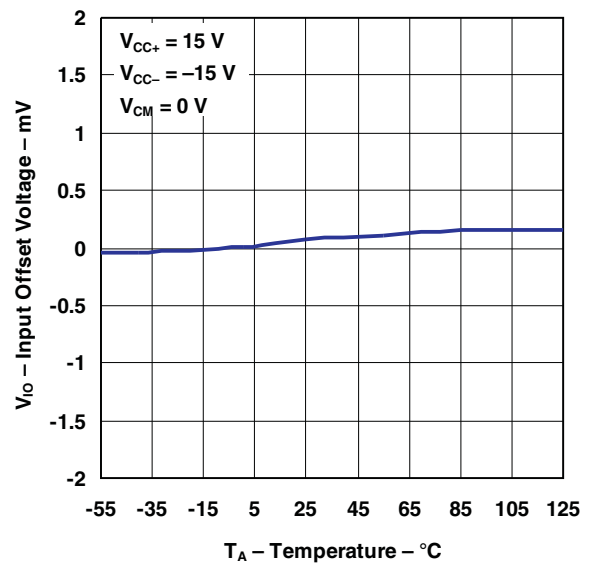
**INPUT BIAS CURRENT**  
 VS  
**SUPPLY VOLTAGE**



**INPUT BIAS CURRENT**  
 VS  
**TEMPERATURE**

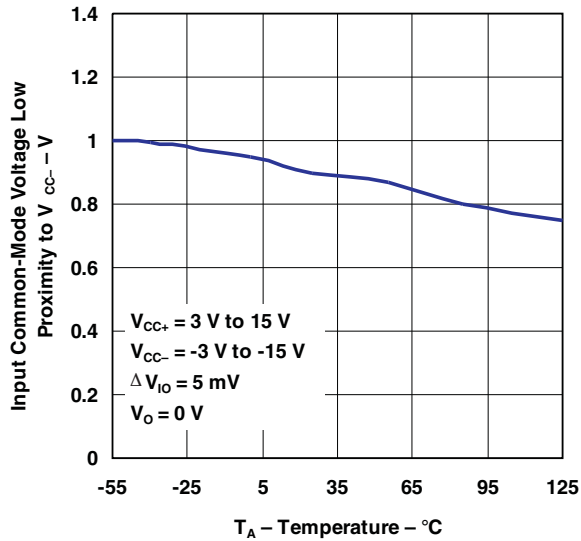


**INPUT OFFSET VOLTAGE**  
 VS  
**TEMPERATURE**

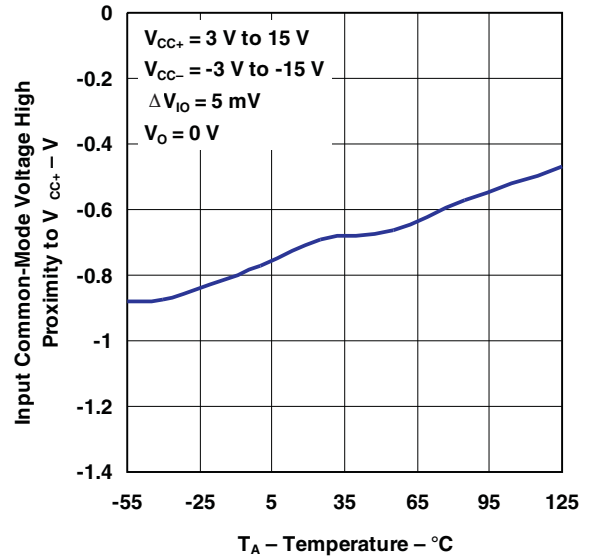


TYPICAL CHARACTERISTICS (continued)

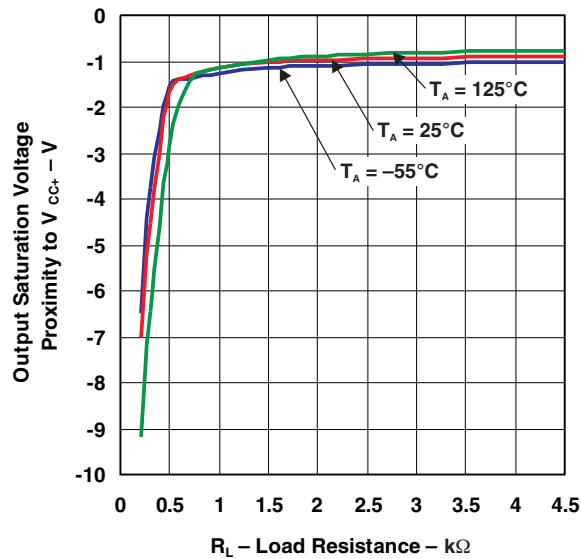
INPUT COMMON-MODE VOLTAGE  
 LOW PROXIMITY TO  $V_{CC-}$   
 VS  
 TEMPERATURE



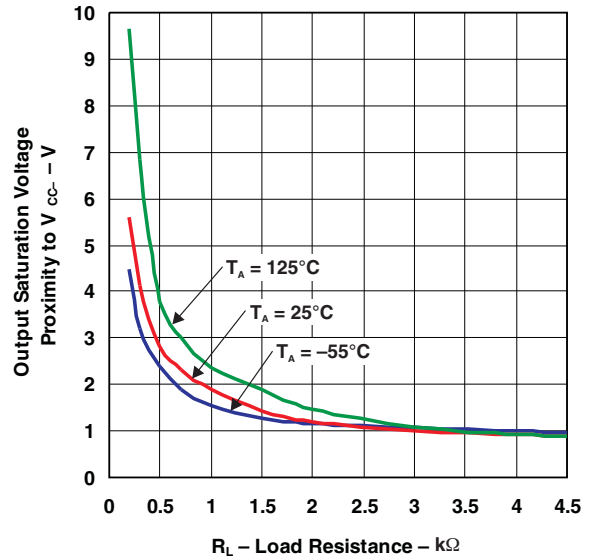
INPUT COMMON-MODE VOLTAGE  
 HIGH PROXIMITY TO  $V_{CC+}$   
 VS  
 TEMPERATURE



OUTPUT SATURATION VOLTAGE PROXIMITY TO  $V_{CC+}$   
 VS  
 LOAD RESISTANCE

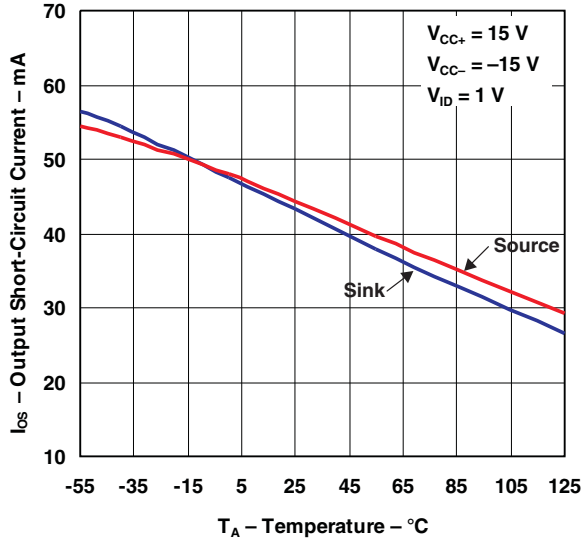


OUTPUT SATURATION VOLTAGE PROXIMITY TO  $V_{CC-}$   
 VS  
 LOAD RESISTANCE

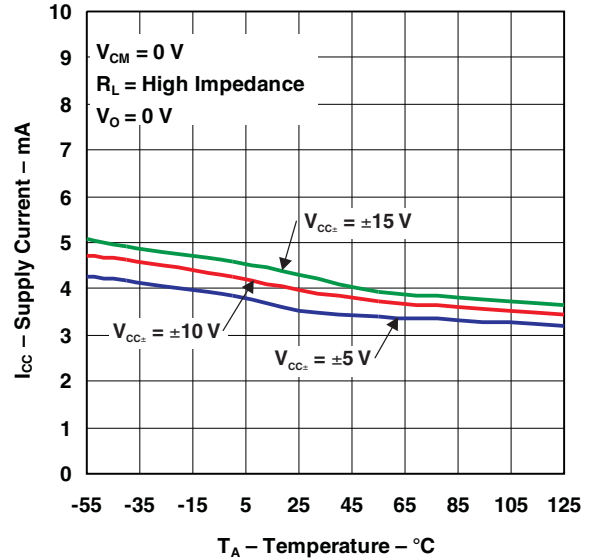


TYPICAL CHARACTERISTICS (continued)

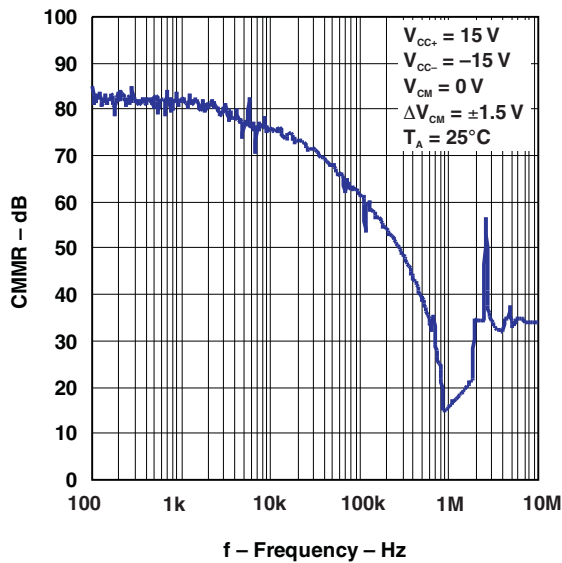
OUTPUT SHORT-CIRCUIT CURRENT  
VS  
TEMPERATURE



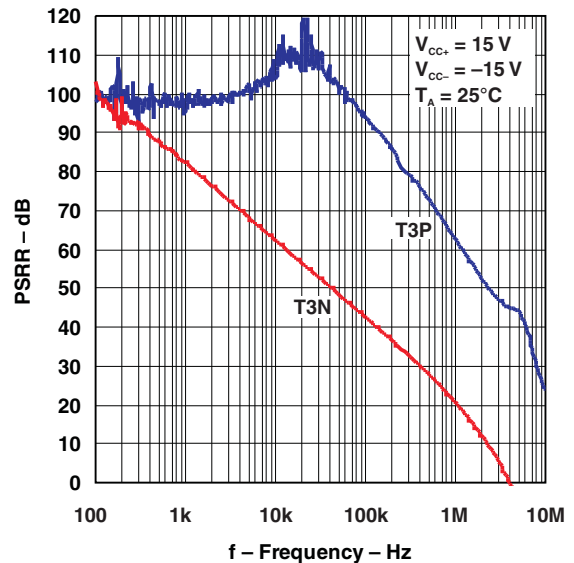
SUPPLY CURRENT  
VS  
TEMPERATURE



CMRR  
VS  
FREQUENCY

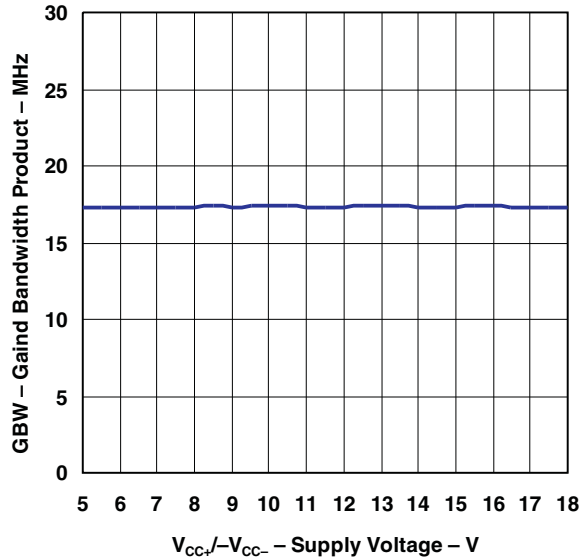


PSSR  
VS  
FREQUENCY

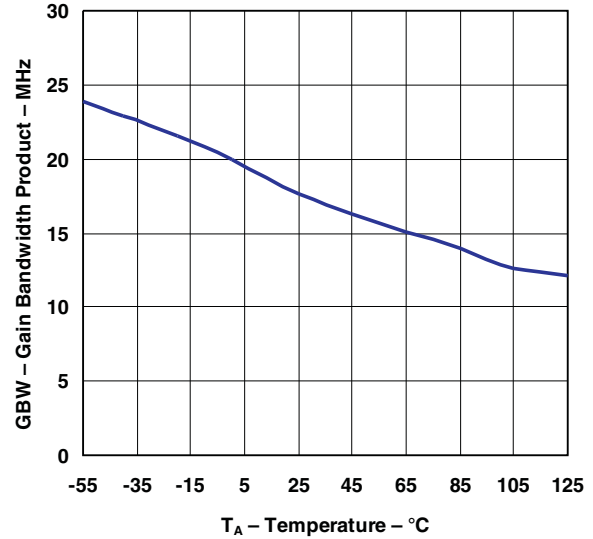


TYPICAL CHARACTERISTICS (continued)

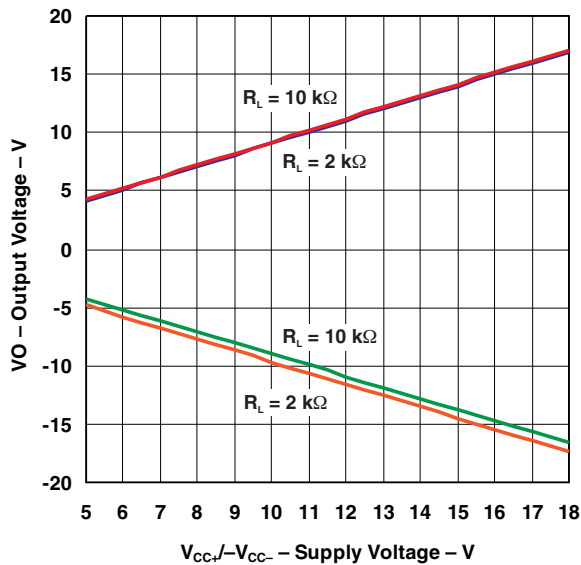
GAIN BANDWIDTH PRODUCT  
 VS  
 SUPPLY VOLTAGE



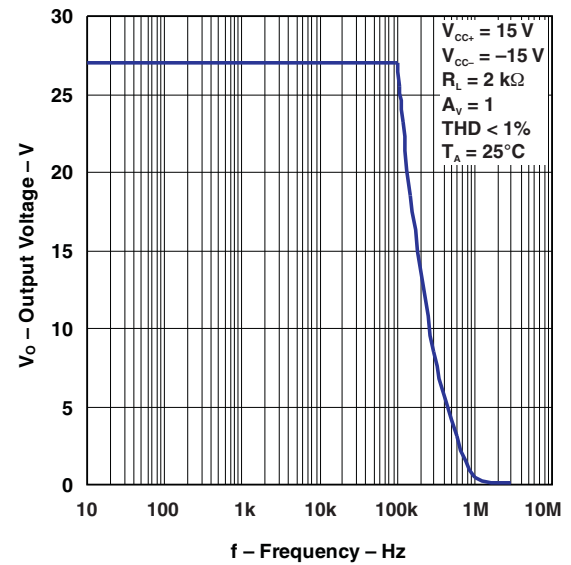
GAIN BANDWIDTH PRODUCT  
 VS  
 TEMPERATURE



OUTPUT VOLTAGE  
 VS  
 SUPPLY VOLTAGE



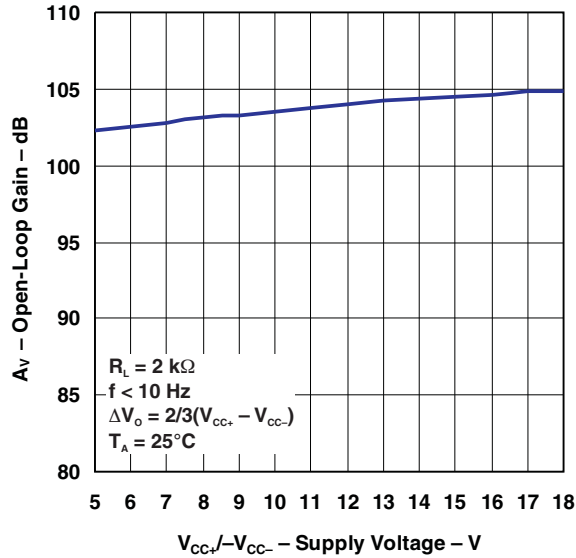
OUTPUT VOLTAGE  
 VS  
 FREQUENCY



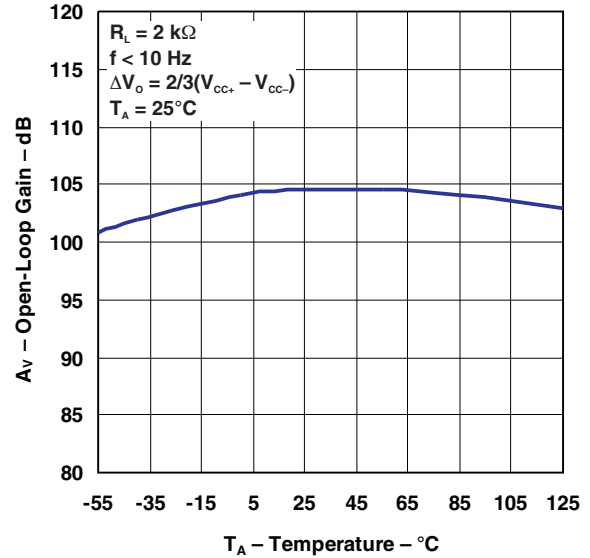


**TYPICAL CHARACTERISTICS (continued)**

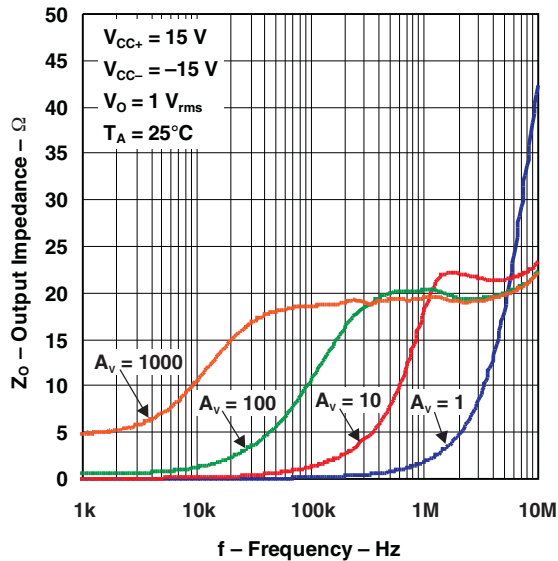
**OPEN-LOOP GAIN  
VS  
SUPPLY VOLTAGE**



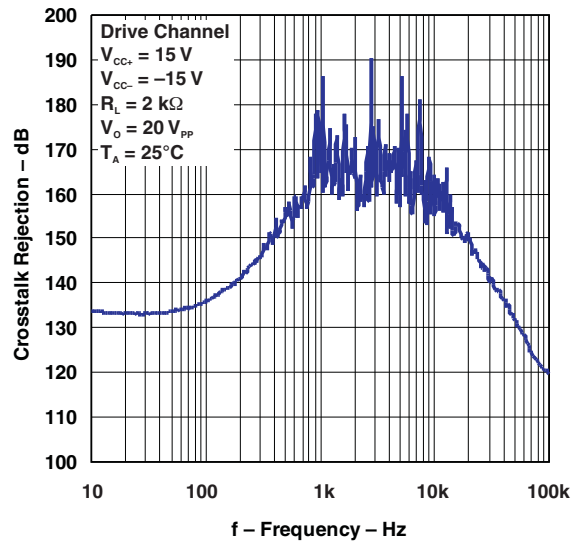
**OPEN-LOOP GAIN  
VS  
TEMPERATURE**



**OUTPUT IMPEDANCE  
VS  
FREQUENCY**

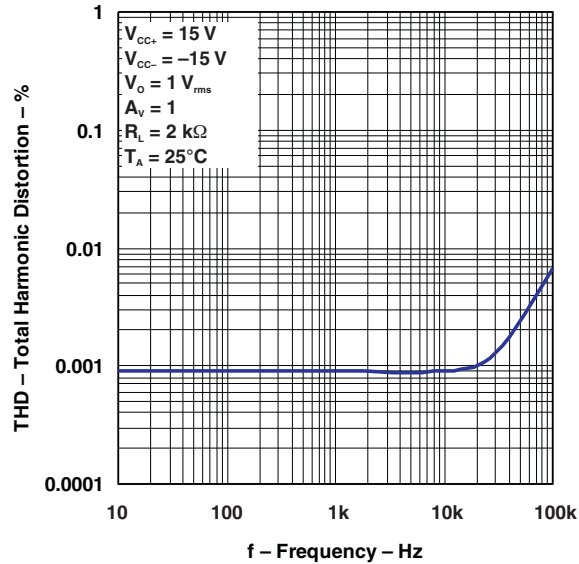


**CROSSTALK REJECTION  
VS  
FREQUENCY**

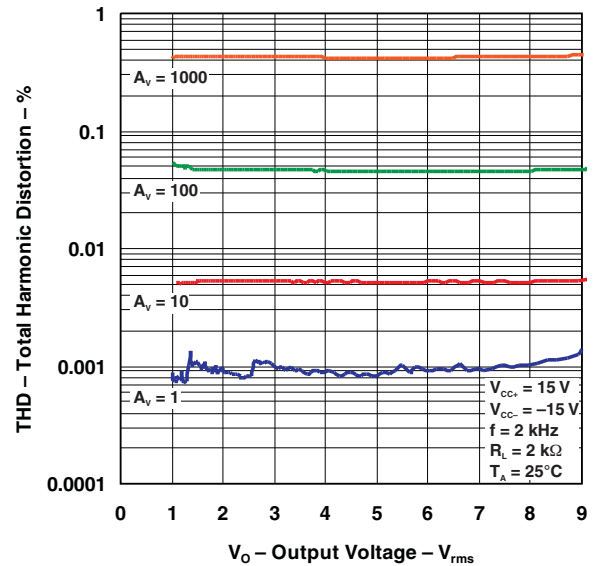


TYPICAL CHARACTERISTICS (continued)

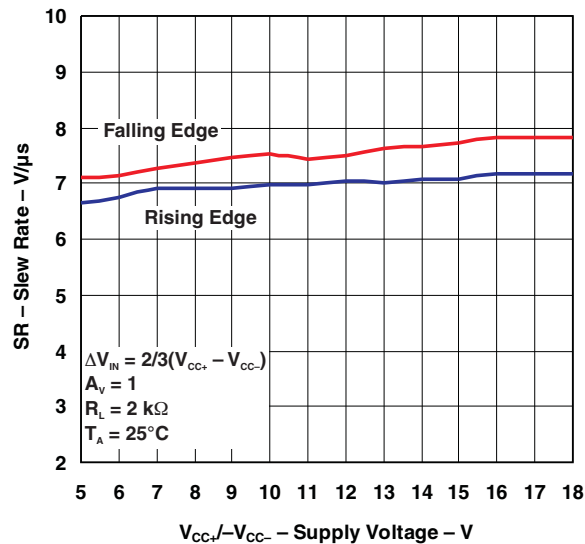
TOTAL HARMONIC DISTORTION  
 VS  
 FREQUENCY



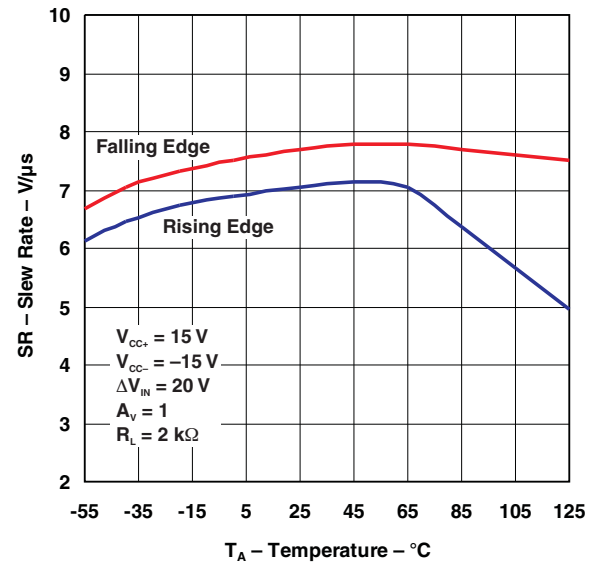
TOTAL HARMONIC DISTORTION  
 VS  
 OUTPUT VOLTAGE



SLEW RATE  
 VS  
 SUPPLY VOLTAGE

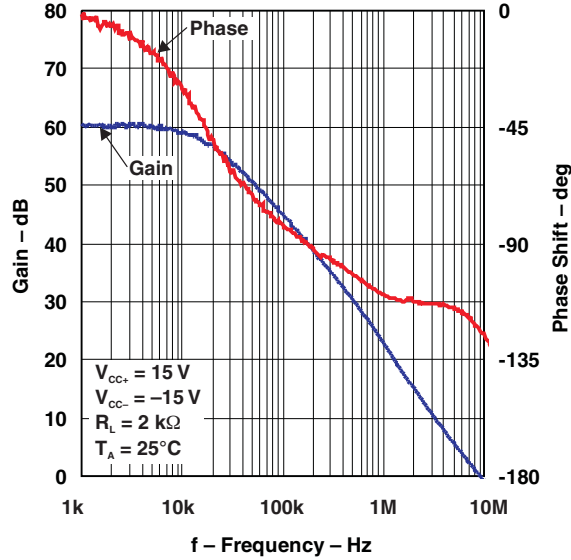


SLEW RATE  
 VS  
 TEMPERATURE

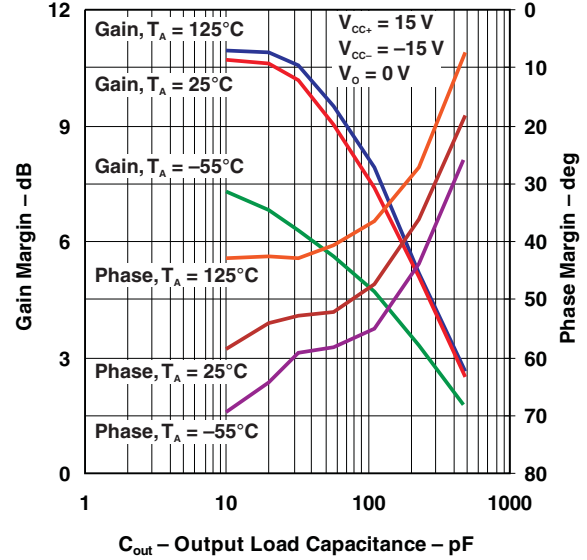


TYPICAL CHARACTERISTICS (continued)

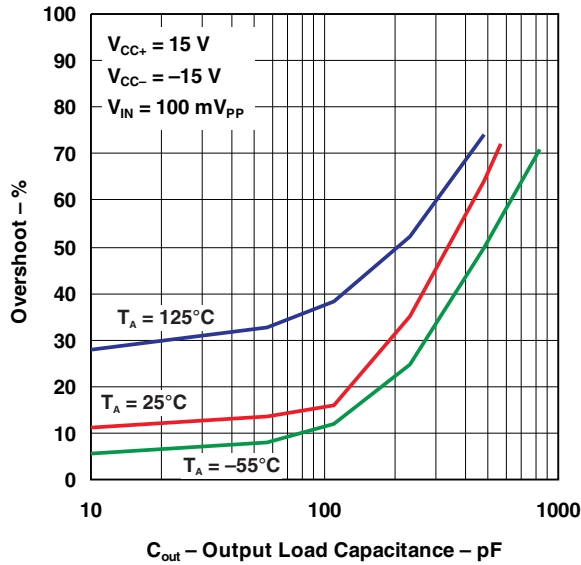
GAIN AND PHASE  
VS  
FREQUENCY



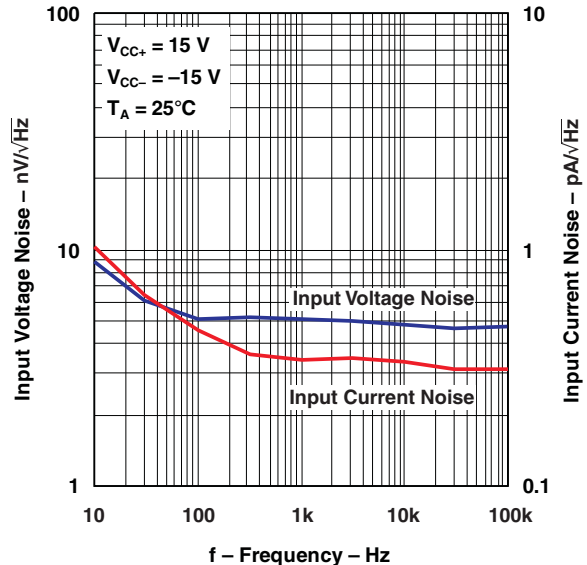
GAIN AND PHASE MARGIN  
VS  
OUTPUT LOAD CAPACITANCE



OVERSHOOT  
VS  
OUTPUT LOAD CAPACITANCE

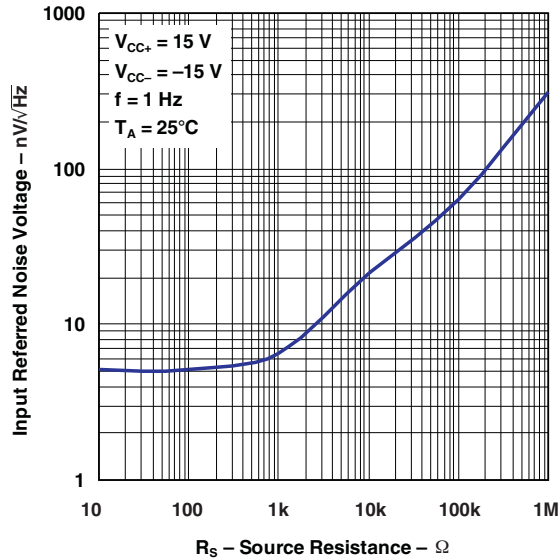


INPUT VOLTAGE AND CURRENT NOISE  
VS  
FREQUENCY

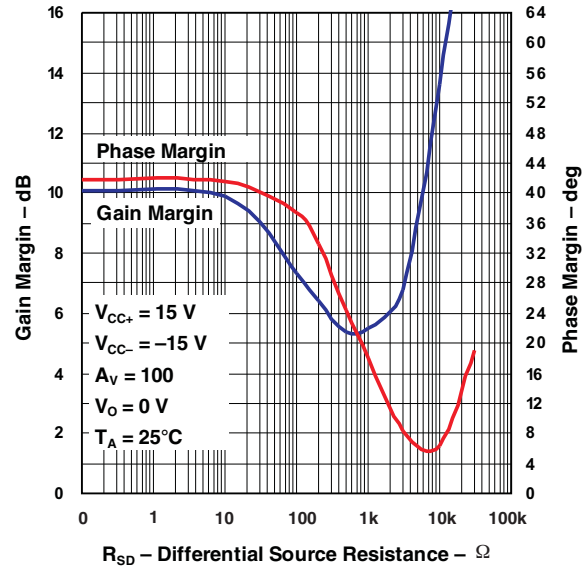


**TYPICAL CHARACTERISTICS (continued)**

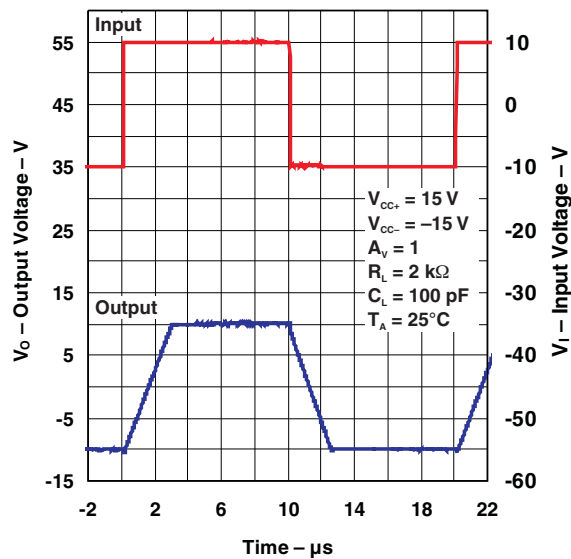
**INPUT REFERRED NOISE VOLTAGE  
 VS  
 SOURCE RESISTANCE**



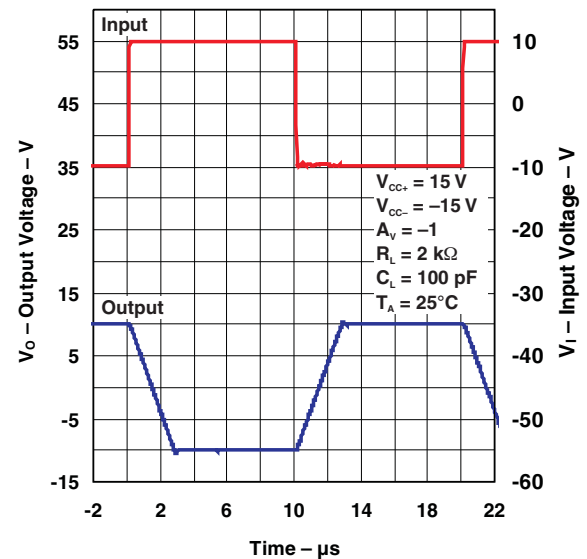
**GAIN AND PHASE MARGIN  
 VS  
 DIFFERENTIAL SOURCE RESISTANCE**



**LARGE SIGNAL TRANSIENT RESPONSE  
 (AV = 1)**

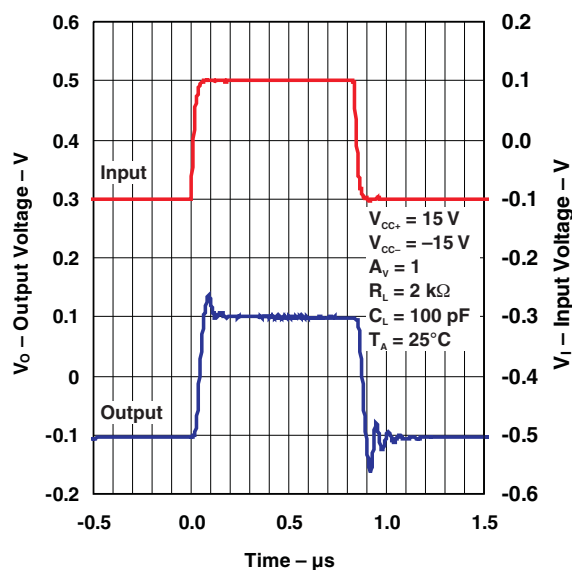


**LARGE SIGNAL TRANSIENT RESPONSE  
 (AV = -1)**

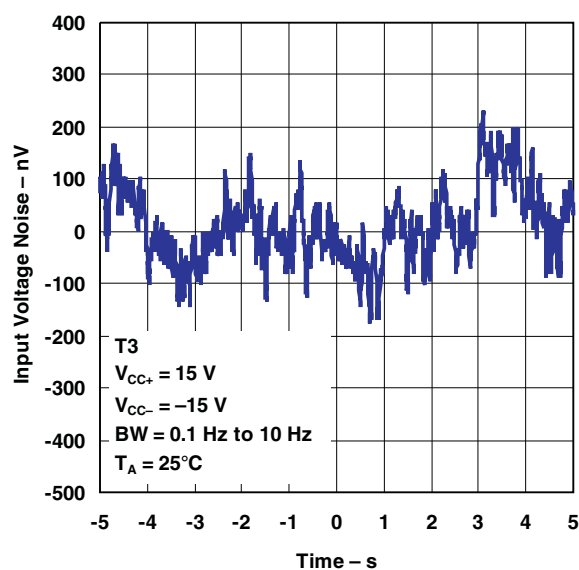


**TYPICAL CHARACTERISTICS (continued)**

**SMALL SIGNAL TRANSIENT RESPONSE**



**LOW\_FREQUENCY NOISE**



APPLICATION INFORMATION

Output Characteristics

All operating characteristics are specified with 100-pF load capacitance. The MC33078 can drive higher capacitance loads. However, as the load capacitance increases, the resulting response pole occurs at lower frequencies, causing ringing, peaking, or oscillation. The value of the load capacitance at which oscillation occurs varies from lot to lot. If an application appears to be sensitive to oscillation due to load capacitance, adding a small resistance in series with the load should alleviate the problem (see Figure 2).

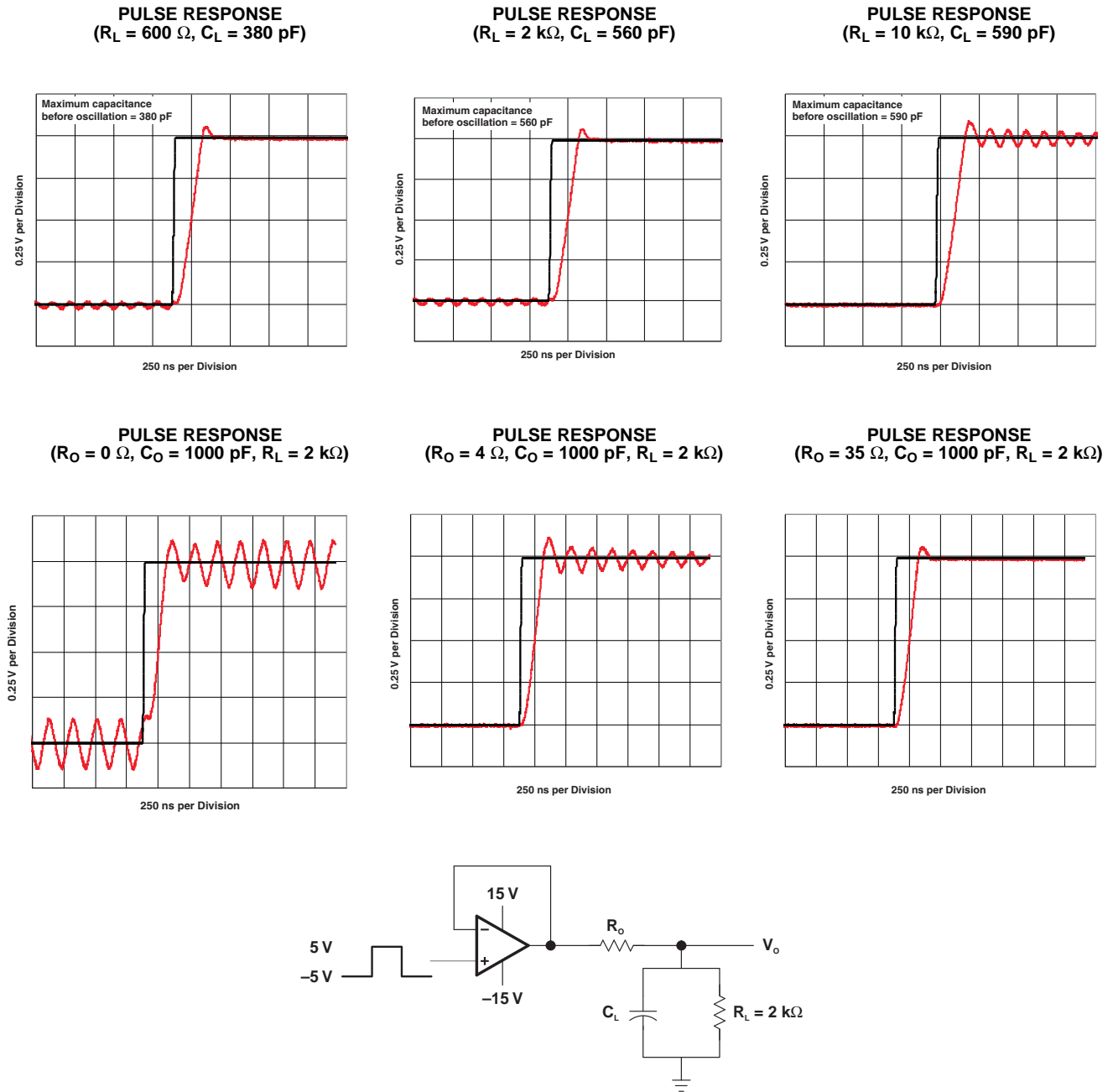


Figure 2. Output Characteristics

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
MC33078D	LIFEBUY	SOIC	D	8	75	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	M33078	
MC33078DGKR	ACTIVE	VSSOP	DGK	8	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MYU	Samples
MC33078DGKRG4	LIFEBUY	VSSOP	DGK	8	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MYU	
MC33078DGKT	LIFEBUY	VSSOP	DGK	8	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MYU	
MC33078DR	ACTIVE	SOIC	D	8	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	M33078	Samples
MC33078DR-NG	ACTIVE	SOIC	D	8	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	M33078	Samples
MC33078DRE4	LIFEBUY	SOIC	D	8	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	M33078	
MC33078P	ACTIVE	PDIP	P	8	50	RoHS & Green	NIPDAU	N / A for Pkg Type	-40 to 85	MC33078P	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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

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**OTHER QUALIFIED VERSIONS OF MC33078 :**

- Enhanced Product : [MC33078-EP](#)

NOTE: Qualified Version Definitions:

- Enhanced Product - Supports Defense, Aerospace and Medical Applications



**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
MC33078DGKR	VSSOP	DGK	8	2500	330.0	12.4	5.3	3.3	1.3	8.0	12.0	Q1
MC33078DGKT	VSSOP	DGK	8	250	180.0	12.4	5.3	3.3	1.3	8.0	12.0	Q1
MC33078DR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
MC33078DR-NG	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
MC33078DGKR	VSSOP	DGK	8	2500	346.0	346.0	35.0
MC33078DGKT	VSSOP	DGK	8	250	200.0	183.0	25.0
MC33078DR	SOIC	D	8	2500	340.5	338.1	20.6
MC33078DR-NG	SOIC	D	8	2500	356.0	356.0	35.0

**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
MC33078D	D	SOIC	8	75	507	8	3940	4.32
MC33078D	D	SOIC	8	75	506.6	8	3940	4.32
MC33078P	P	PDIP	8	50	506	13.97	11230	4.32

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

DGK (S-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per end.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
  - E. Falls within JEDEC MO-187 variation AA, except interlead flash.



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.



D0008A

# PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

NOTES:

- 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.
- This drawing is subject to change without notice.
- 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.
- This dimension does not include interlead flash.
- 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

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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.

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