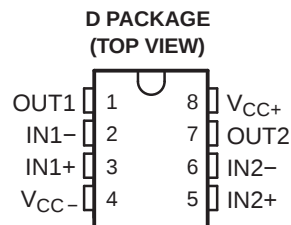


FEATURES

- **Controlled Baseline**
 - One Assembly/Test Site, One Fabrication Site
- **Enhanced Diminishing Manufacturing Sources (DMS) Support**
- **Enhanced Product-Change Notification**
- **Qualification Pedigree** ⁽¹⁾
- **Dual-Supply Operation . . . ± 5 V to ± 18 V**
- **Low Noise Voltage . . . $4.5 \text{ nV}/\sqrt{\text{Hz}}$**
- **Low Input Offset Voltage . . . 0.15 mV**
- **Low Total Harmonic Distortion . . . 0.002%**
- **High Slew Rate . . . 7 V/ μ s**
- **High-Gain Bandwidth Product . . . 16 MHz**
- **High Open-Loop AC Gain . . . 800 at 20 kHz**
- **Large Output-Voltage Swing . . . 14.1 V to -14.6 V**
- **Excellent Gain and Phase Margins**

(1) Component qualification in accordance with JEDEC and industry standards to ensure reliable operation over an extended temperature range. This includes, but is not limited to, Highly Accelerated Stress Test (HAST) or biased 85/85, temperature cycle, autoclave or unbiased HAST, electromigration, bond intermetallic life, and mold compound life. Such qualification testing should not be viewed as justifying use of this component beyond specified performance and environmental limits.



DESCRIPTION/ORDERING INFORMATION

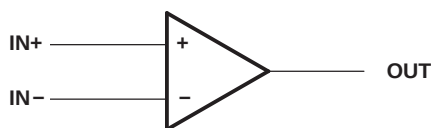
The MC33078-EP is a bipolar dual operational amplifier with high-performance specifications for use in quality audio and data-signal applications. This device operates over a wide range of single- and dual-supply voltages and offers low noise, high-gain bandwidth, and high slew rate. Additional features 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 ⁽¹⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-55°C to 125°C	SOIC – D	Reel of 2500	MC33078MDREP	33078M

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

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.

MC33078-EP

DUAL HIGH-SPEED LOW-NOISE OPERATIONAL AMPLIFIER

SLOS495 – OCTOBER 2006

Absolute Maximum Ratings⁽¹⁾

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

		MIN	MAX	UNIT
V _{CC+}	Supply voltage ⁽²⁾		18	V
V _{CC-}	Supply voltage ⁽²⁾		-18	V
V _{CC-} to V _{CC+}	Supply voltage		36	V
	Input voltage, either input ⁽²⁾⁽³⁾		V _{CC-} or V _{CC+}	V
	Input current ⁽⁴⁾		±10	mA
	Duration of output short circuit ⁽⁵⁾		Unlimited	
θ _{JA}	Package thermal impedance ⁽⁶⁾⁽⁷⁾		97	°C/W
T _J	Operating virtual junction temperature		150	°C
T _{stg}	Storage temperature range ⁽⁸⁾	-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_{CC+} and V_{CC-}.
- (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_{J(max)}, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is P_D = (T_{J(max)} - T_A)/θ_{JA}. Operating at the absolute maximum T_J of 150°C can affect reliability.
- (7) The package thermal impedance is calculated in accordance with JESD 51-7.
- (8) Long-term high-temperature storage and/or extended use at maximum recommended operating conditions may result in a reduction of overall device life. See http://www.ti.com/ep_quality for additional information on enhanced plastic packaging.

Recommended Operating Conditions

		MIN	MAX	UNIT
V _{CC-}	Supply voltage	-5	-18	V
V _{CC+}		5	18	
T _A	Operating free-air temperature	-55	125	°C

Electrical Characteristics

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

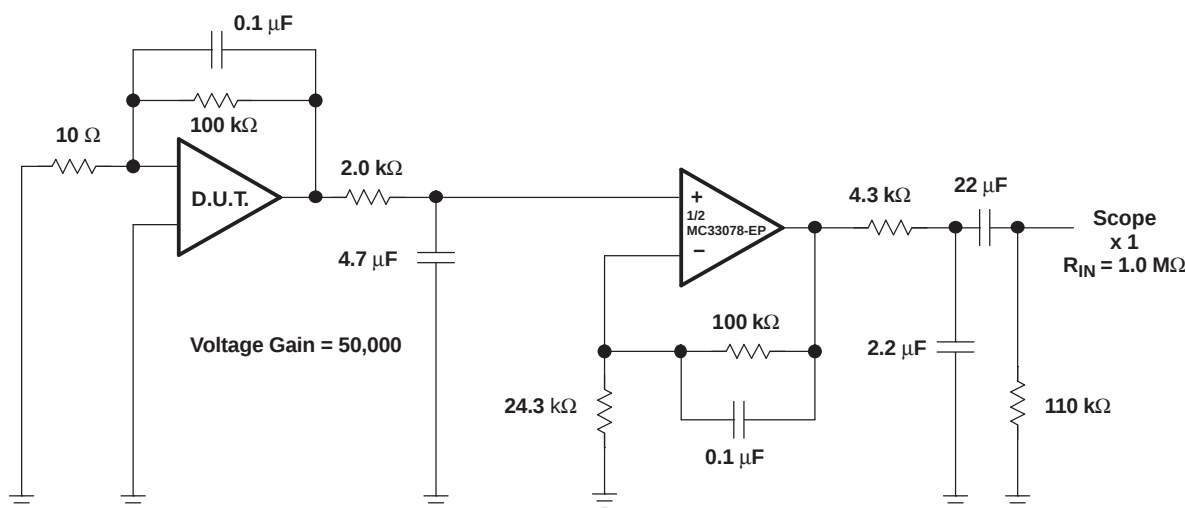
PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	$V_O = 0$, $R_S = 10\ \Omega$, $V_{CM} = 0$	$T_A = 25^\circ\text{C}$		0.15	2	mV
			$T_A = -55^\circ\text{C}$ to 125°C			3	
αV_{IO}	Input offset voltage temperature coefficient	$V_O = 0$, $R_S = 10\ \Omega$, $V_{CM} = 0$	$T_A = -55^\circ\text{C}$ to 125°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
			$T_A = -55^\circ\text{C}$ to 125°C			800	
I_{IO}	Input offset current	$V_O = 0$, $V_{CM} = 0$	$T_A = 25^\circ\text{C}$		25	150	nA
			$T_A = -55^\circ\text{C}$ to 125°C			175	
V_{ICR}	Common-mode input voltage range	$\Delta V_{IO} = 5\text{ mV}$, $V_O = 0$		± 13	± 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
			$T_A = -55^\circ\text{C}$ to 125°C	80			
V_{OM}	Maximum output voltage swing	$V_{ID} = \pm 1\text{ V}$	$R_L = 600\ \Omega$		10.7		V
			V_{OM+}				
			V_{OM-}		-11.9		
			$R_L = 2\text{ k}\Omega$		13.2	13.8	
			V_{OM+}				
			V_{OM-}		-13.2	-13.7	
			$R_L = 10\text{ k}\Omega$		13.5	14.1	
			V_{OM+}				
			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 V , $V_{CC-} = -5\text{ V}$ to -15 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
			$T_A = -55^\circ\text{C}$ to 125°C			3.5	

(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/ μs
GBW Gain bandwidth product	$f = 100\text{ kHz}$		16		MHz
B_1 Unity gain frequency	Open loop		9		MHz
Gain margin	$R_L = 2\text{ k}\Omega$	$C_L = 0\text{ pF}$		-11	dB
		$C_L = 100\text{ pF}$		-6	
ϕ_m Phase margin	$R_L = 2\text{ k}\Omega$	$C_L = 0\text{ pF}$		55	deg
		$C_L = 100\text{ pF}$		40	
Amplifier-to-amplifier 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	$V_O = 3\text{ V}_{\text{rms}}$, $A_{VD} = 1$, $R_L = 2\text{ k}\Omega$, $f = 20\text{ Hz to } 20\text{ kHz}$		0.002		%
z_o Open-loop output impedance	$V_O = 0$, $f = 9\text{ MHz}$		37		Ω
r_{id} Differential input resistance	$V_{CM} = 0$		175		k Ω
C_{id} Differential input capacitance	$V_{CM} = 0$		12		pF
V_n Equivalent input noise voltage	$f = 1\text{ kHz}$, $R_S = 100\text{ }\Omega$		4.5		nV/ $\sqrt{\text{Hz}}$
I_n Equivalent input noise current	$f = 1\text{ kHz}$		0.5		pA/ $\sqrt{\text{Hz}}$

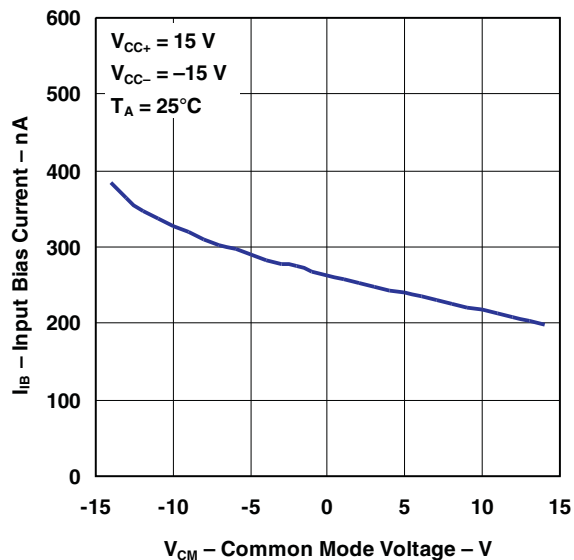


NOTE: All capacitors are nonpolarized.

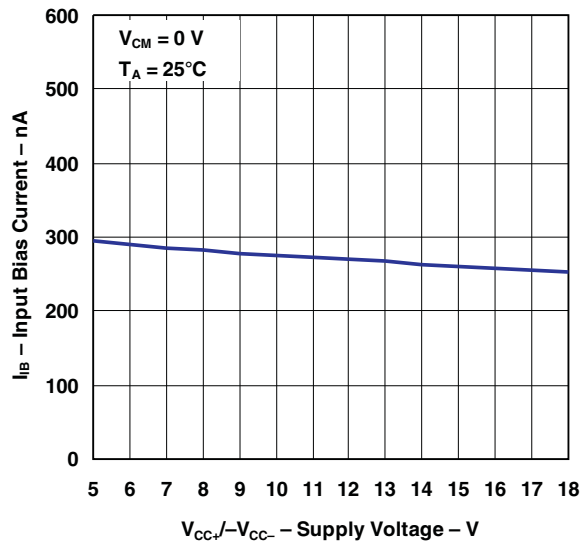
Figure 1. Voltage Noise Test Circuit (0.1 Hz to 10 Hz_{p-p})

TYPICAL CHARACTERISTICS

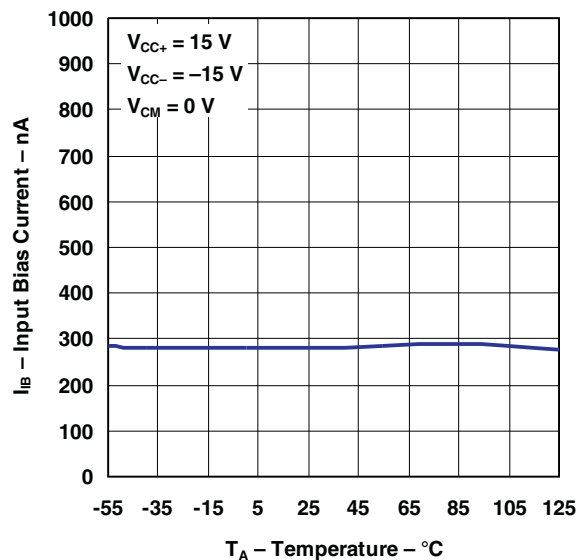
INPUT BIAS CURRENT
VS
COMMON-MODE VOLTAGE



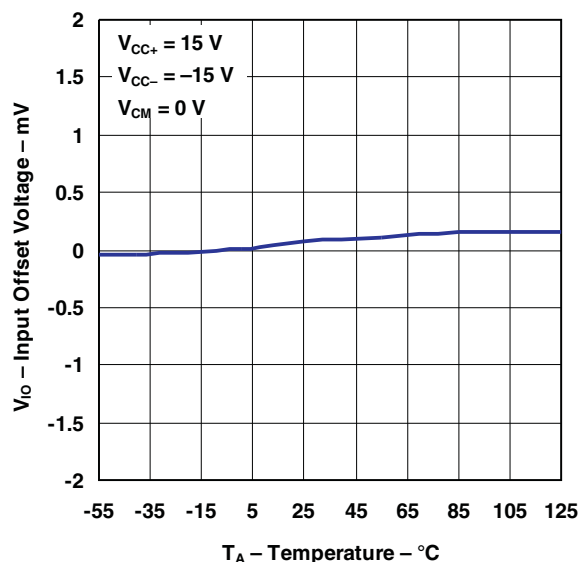
INPUT BIAS CURRENT
VS
SUPPLY VOLTAGE



INPUT BIAS CURRENT
VS
TEMPERATURE

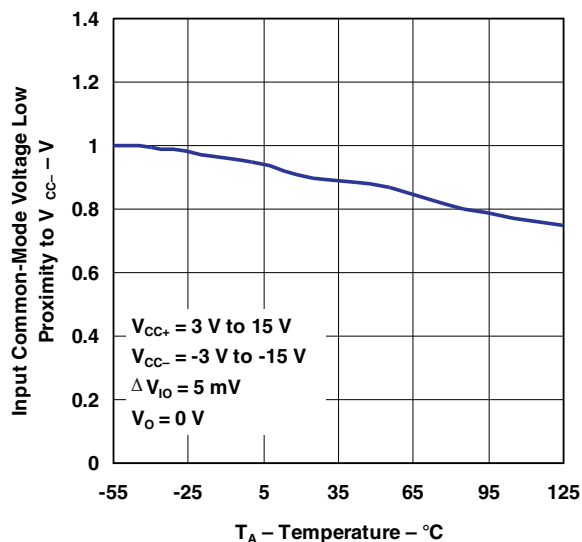


INPUT OFFSET VOLTAGE
VS
TEMPERATURE

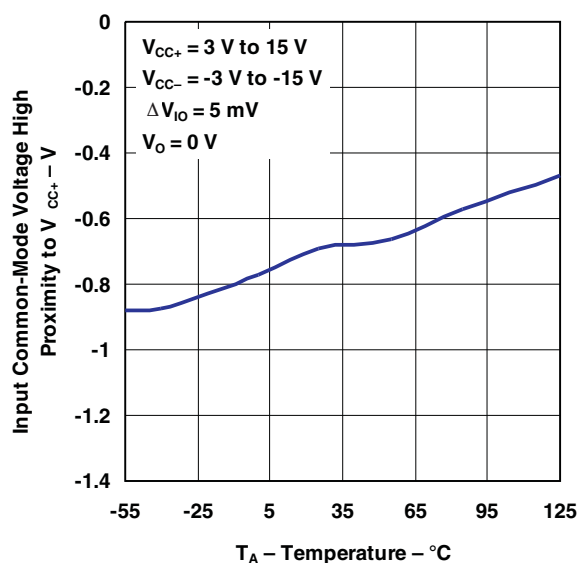


TYPICAL CHARACTERISTICS (continued)

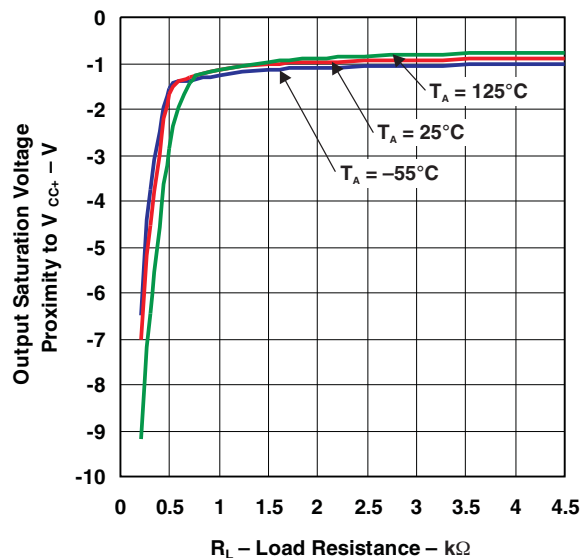
INPUT COMMON-MODE VOLTAGE
LOW PROXIMITY TO V_{CC-}
VS
TEMPERATURE



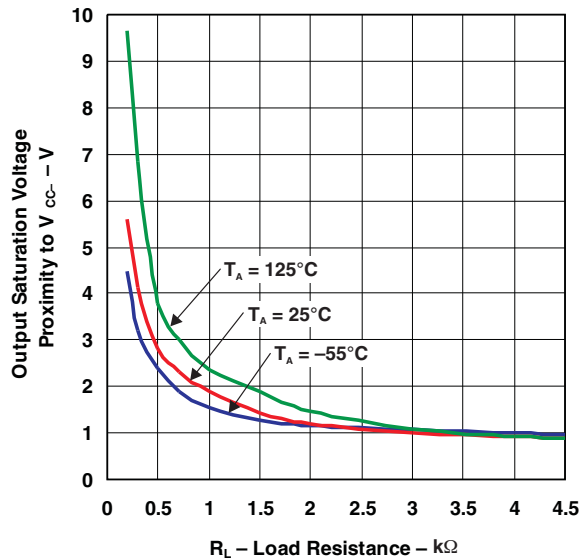
INPUT COMMON-MODE VOLTAGE
HIGH PROXIMITY TO V_{CC+}
VS
TEMPERATURE



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

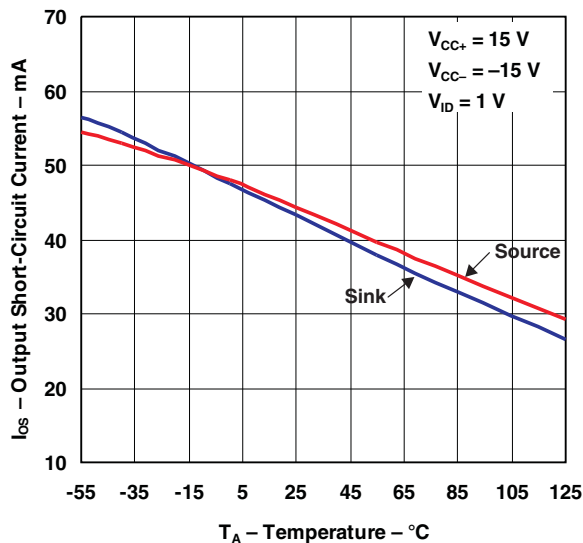


OUTPUT SATURATION VOLTAGE PROXIMITY TO V_{CC-}
VS
LOAD RESISTANCE

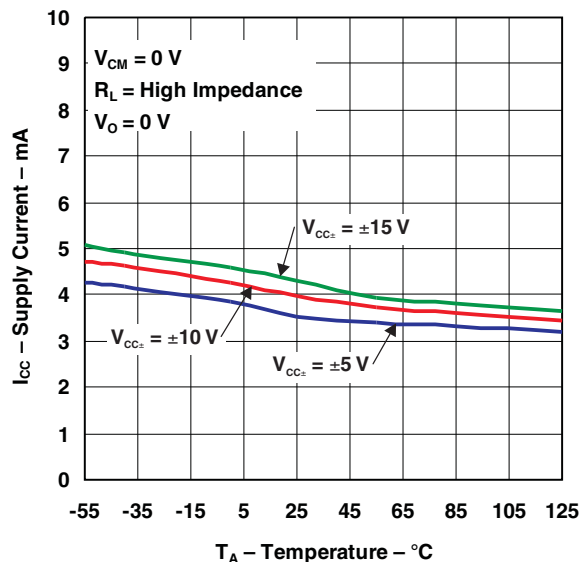


TYPICAL CHARACTERISTICS (continued)

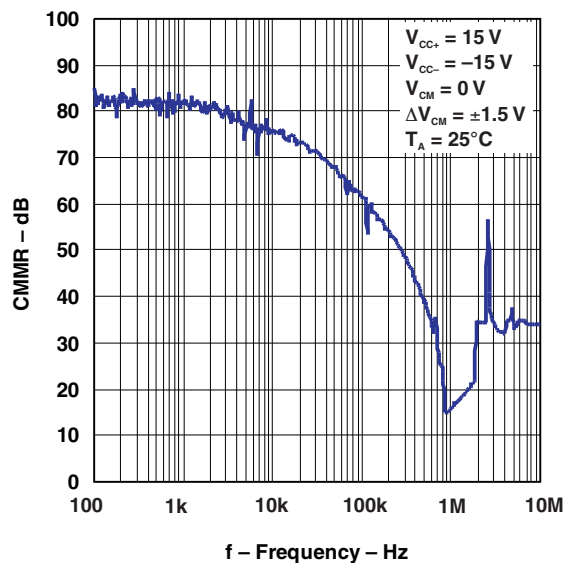
OUTPUT SHORT-CIRCUIT CURRENT
VS
TEMPERATURE



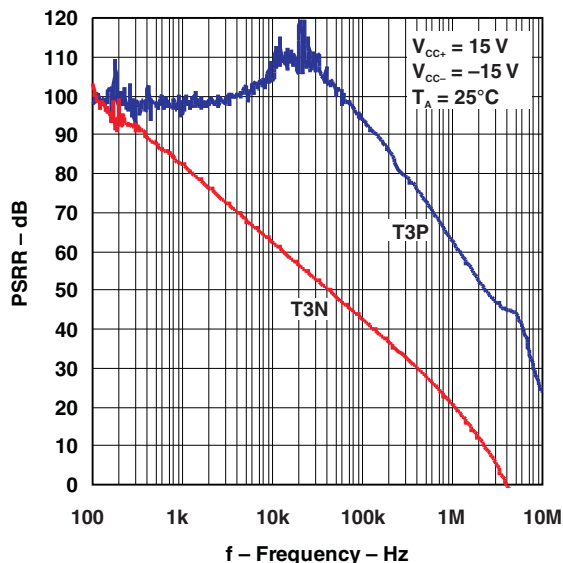
SUPPLY CURRENT
VS
TEMPERATURE



CMRR
VS
FREQUENCY

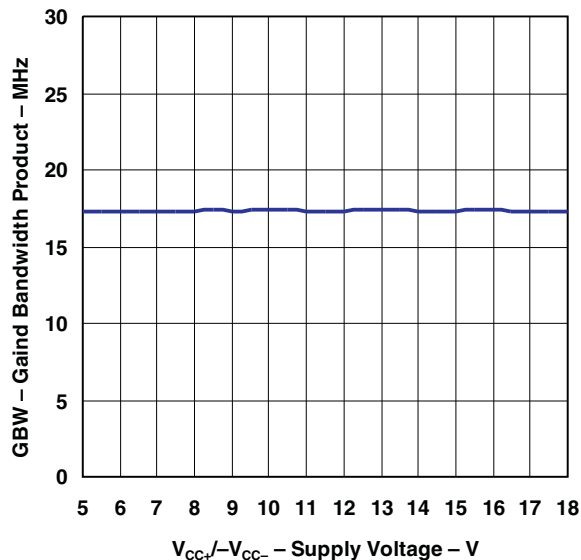


PSSR
VS
FREQUENCY

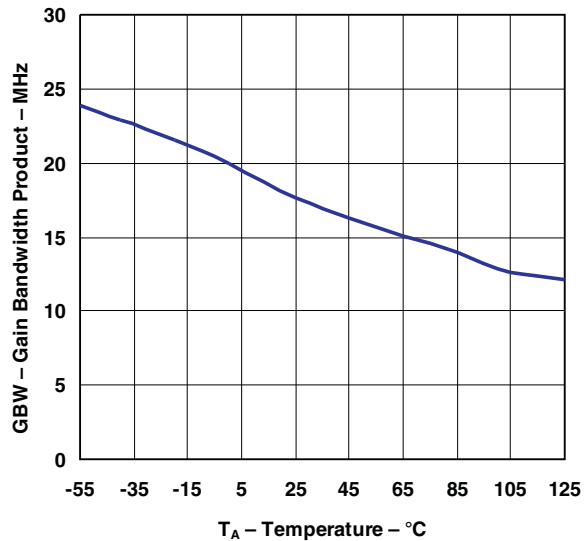


TYPICAL CHARACTERISTICS (continued)

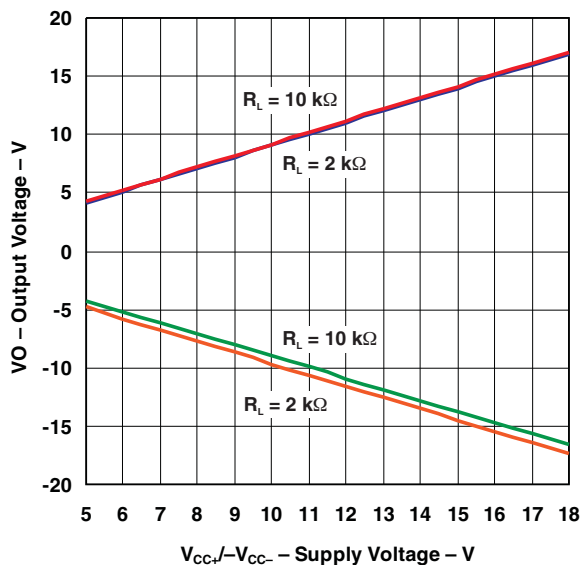
GAIN BANDWIDTH PRODUCT
vs
SUPPLY VOLTAGE



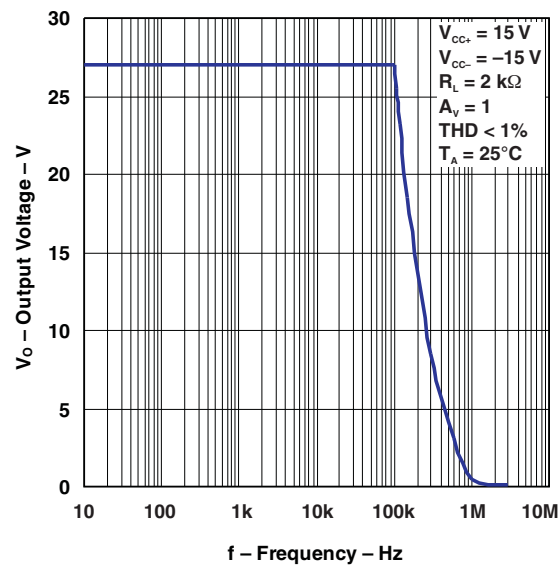
GAIN BANDWIDTH PRODUCT
vs
TEMPERATURE



OUTPUT VOLTAGE
vs
SUPPLY VOLTAGE

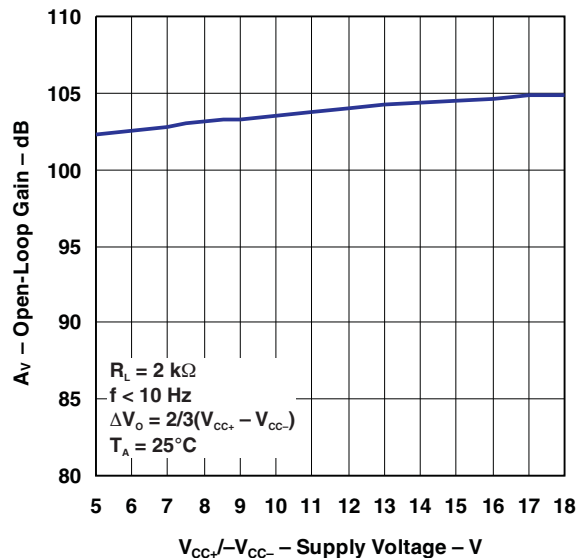


OUTPUT VOLTAGE
vs
FREQUENCY

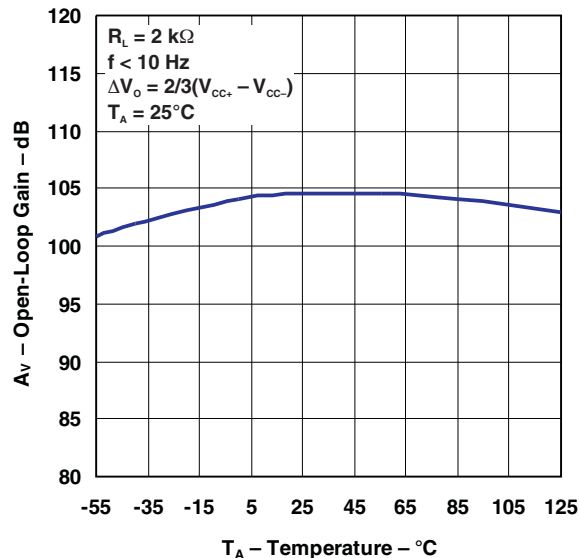


TYPICAL CHARACTERISTICS (continued)

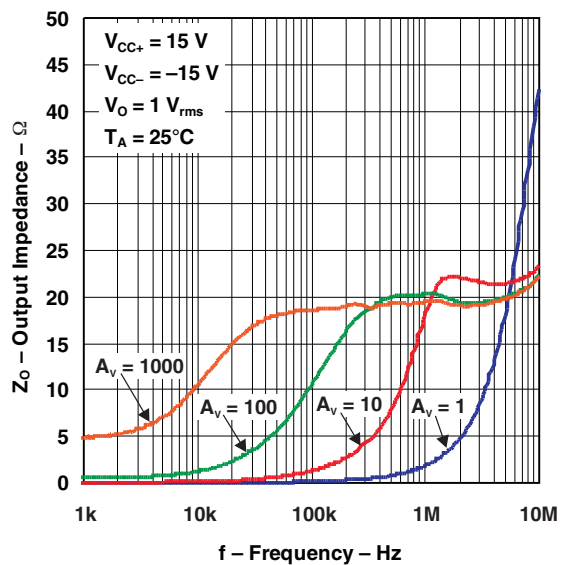
OPEN-LOOP GAIN
vs
SUPPLY VOLTAGE



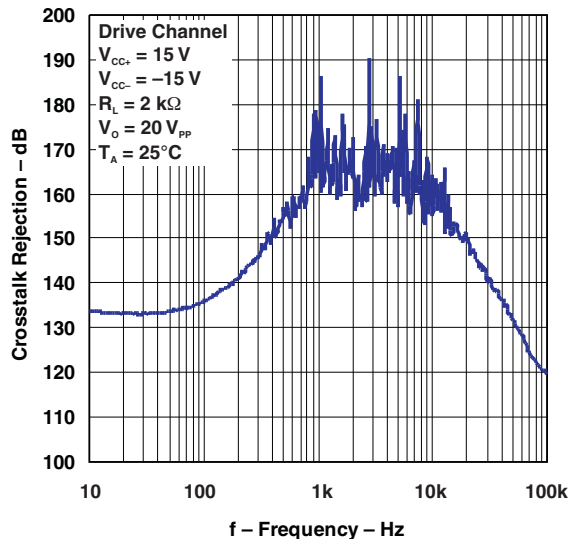
OPEN-LOOP GAIN
vs
TEMPERATURE



OUTPUT IMPEDANCE
vs
FREQUENCY

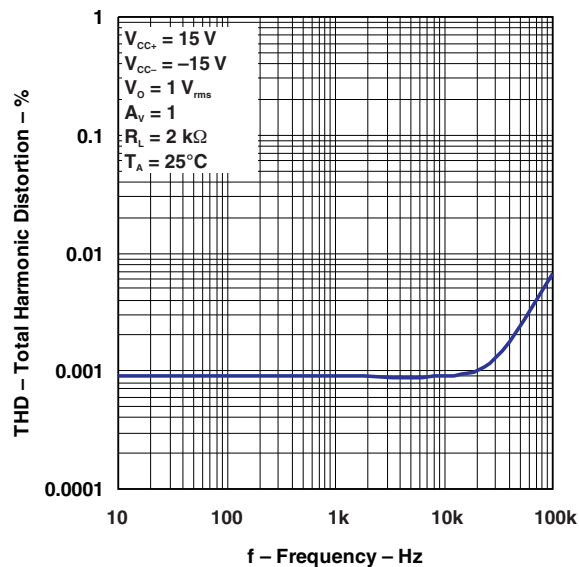


CROSSTALK REJECTION
vs
FREQUENCY

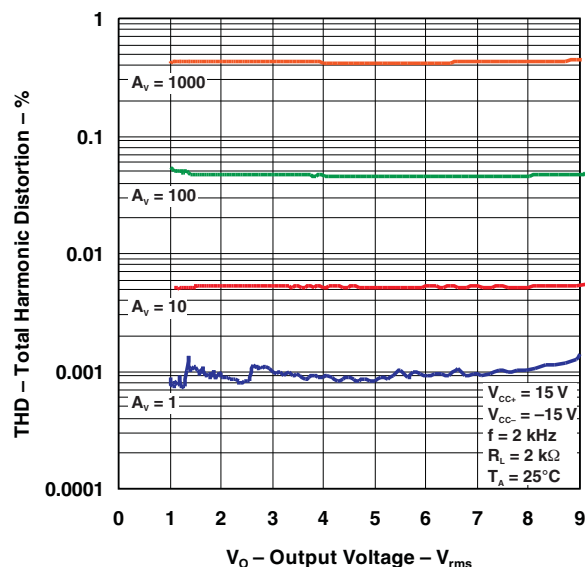


TYPICAL CHARACTERISTICS (continued)

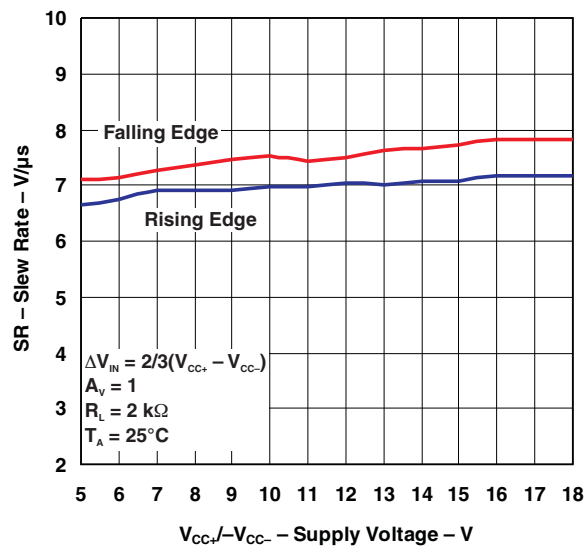
TOTAL HARMONIC DISTORTION
VS
FREQUENCY



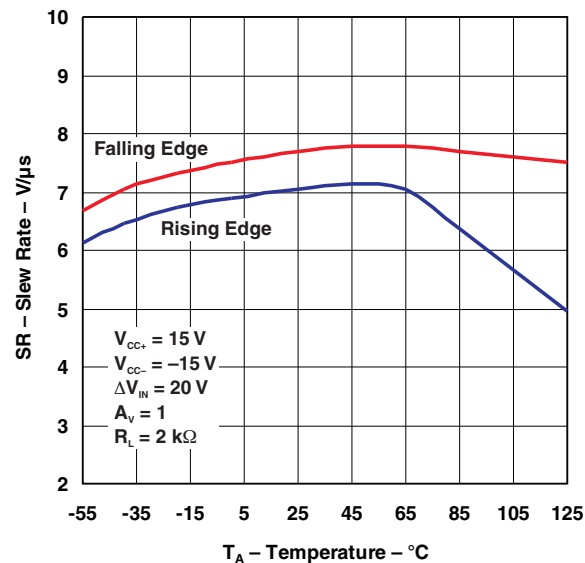
TOTAL HARMONIC DISTORTION
VS
OUTPUT VOLTAGE



SLEW RATE
VS
SUPPLY VOLTAGE

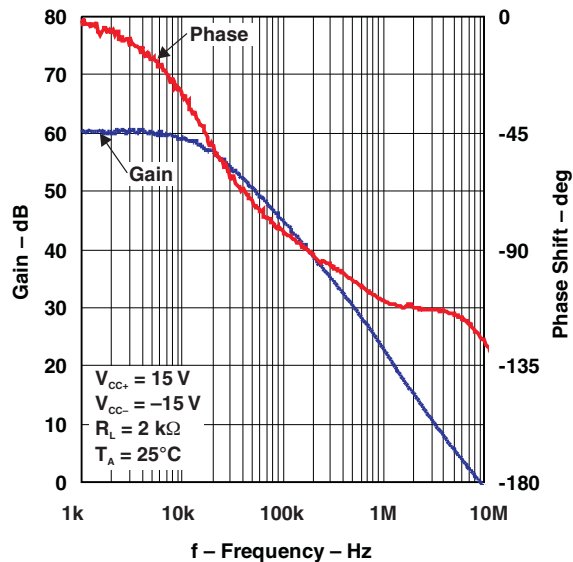


SLEW RATE
VS
TEMPERATURE

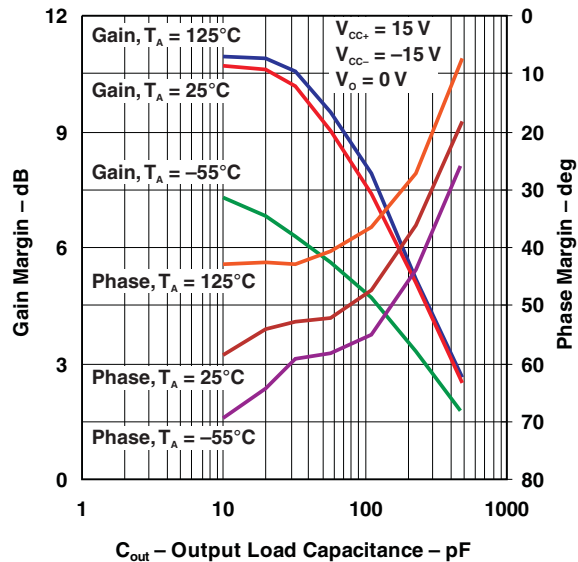


TYPICAL CHARACTERISTICS (continued)

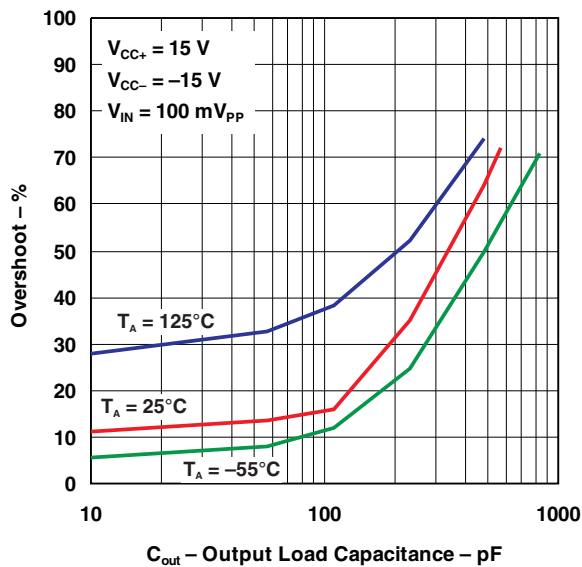
GAIN AND PHASE
VS
FREQUENCY



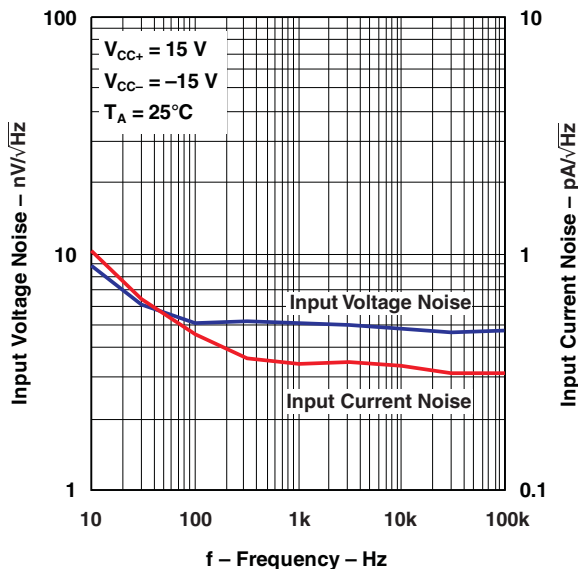
GAIN AND PHASE MARGIN
VS
OUTPUT LOAD CAPACITANCE



OVERSHOOT
VS
OUTPUT LOAD CAPACITANCE

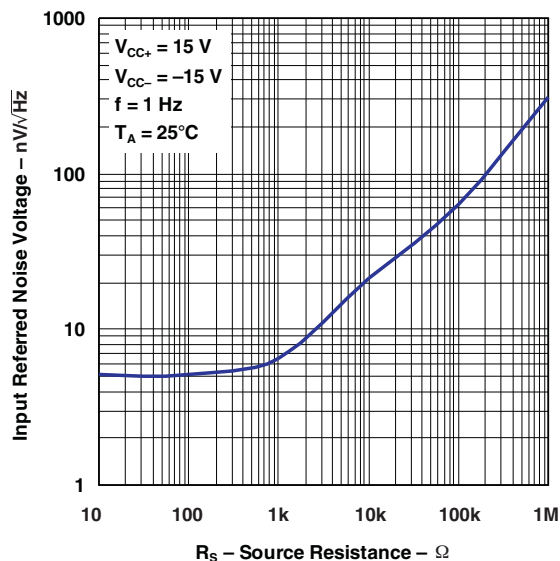


INPUT VOLTAGE AND CURRENT NOISE
VS
FREQUENCY

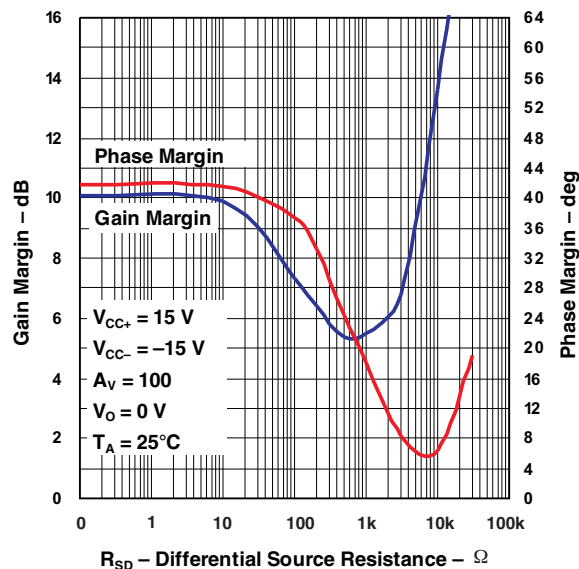


TYPICAL CHARACTERISTICS (continued)

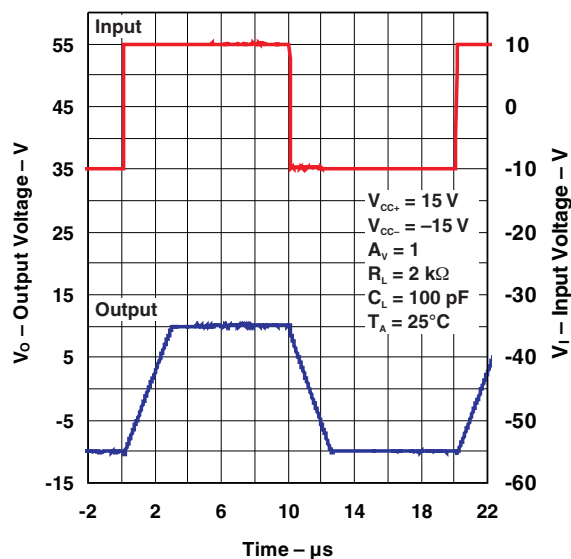
INPUT REFERRED NOISE VOLTAGE
VS
SOURCE RESISTANCE



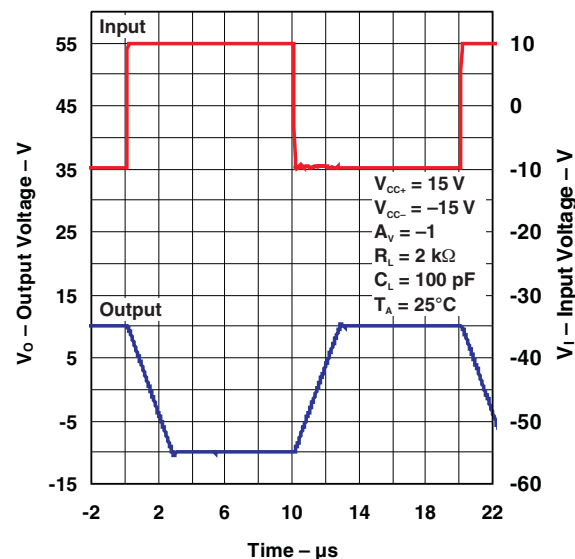
GAIN AND PHASE MARGIN
VS
DIFFERENTIAL SOURCE RESISTANCE



LARGE SIGNAL TRANSIENT RESPONSE
($A_V = 1$)

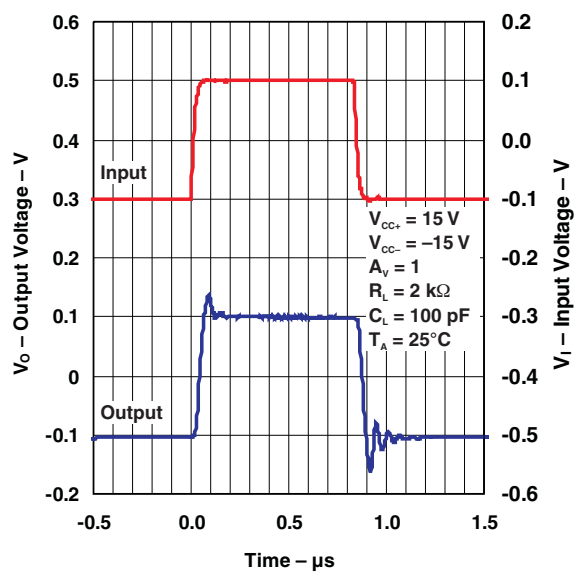


LARGE SIGNAL TRANSIENT RESPONSE
($A_V = -1$)

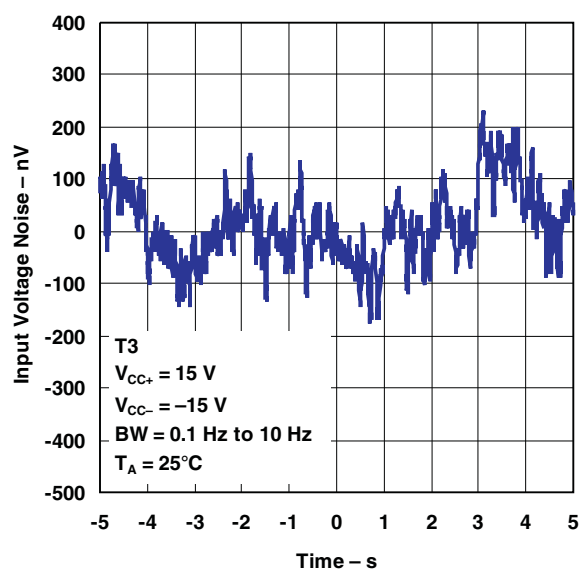


TYPICAL CHARACTERISTICS (continued)

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).

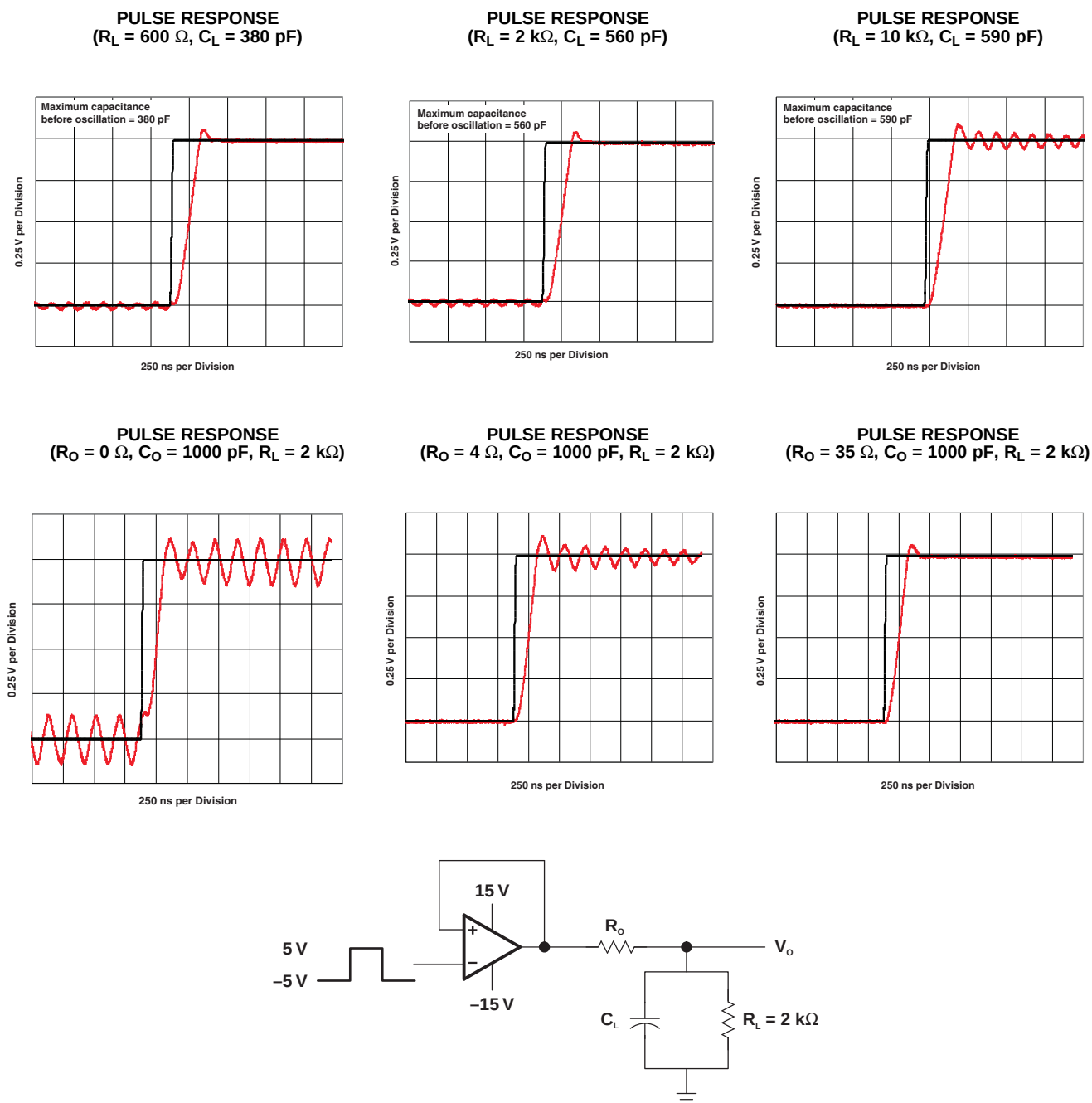


Figure 2. Output Characteristics

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
MC33078MDREP	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	33078M	Samples
V62/07606-01XE	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	33078M	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 MC33078-EP :

- Catalog: [MC33078](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION


*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
MC33078MDREP	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)
MC33078MDREP	SOIC	D	8	2500	367.0	367.0	35.0

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



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

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - 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.
 - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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