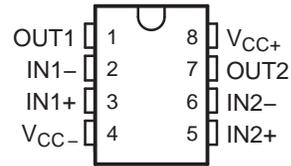


FEATURES

- 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 . . . $7 \text{ V}/\mu\text{s}$
- 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

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.

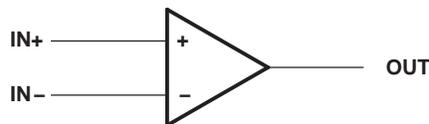
ORDERING INFORMATION

T_A	PACKAGE ⁽¹⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING ⁽²⁾
-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.

(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⁽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+} - 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, junction to free air ⁽⁶⁾⁽⁷⁾	D package	97	°C/W
		DGK package	172	
		P package	85	
T _J	Operating virtual junction temperature		150	°C
T _{stg}	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_{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.

Recommended Operating Conditions

		MIN	MAX	UNIT
V _{CC-}	Supply voltage	-5	-18	V
V _{CC+}		5	18	
T _A	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)

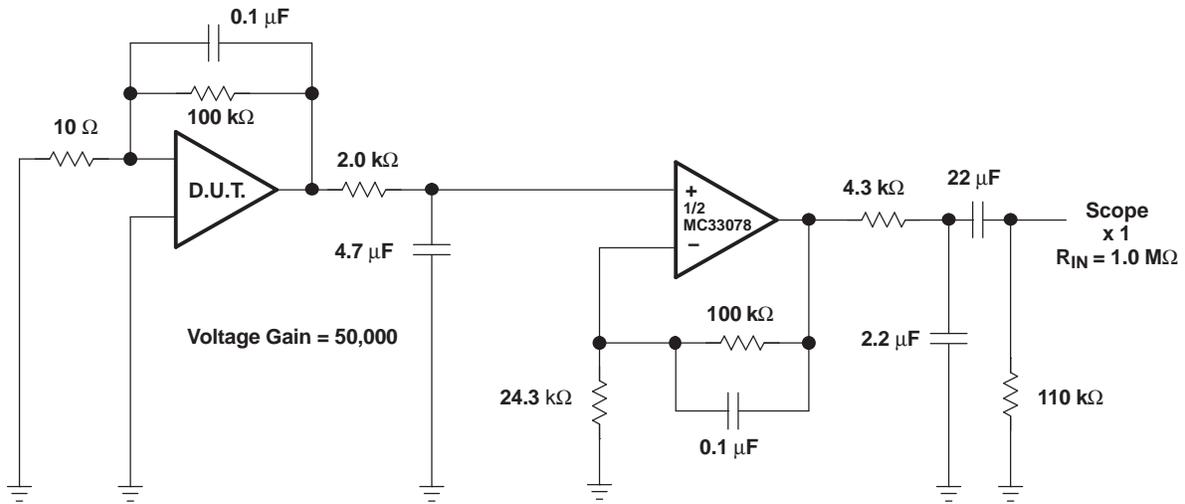
PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	$V_O = 0$, $R_S = 10\ \Omega$, $V_{CM} = 0$	$T_A = 25^\circ\text{C}$	0.15	2	3	mV
			$T_A = -40^\circ\text{C}$ to 85°C				
αV_{IO}	Input offset voltage temperature coefficient	$V_O = 0$, $R_S = 10\ \Omega$, $V_{CM} = 0$	$T_A = -40^\circ\text{C}$ to 85°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°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°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
			$T_A = -40^\circ\text{C}$ to 85°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 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
			$T_A = -40^\circ\text{C}$ to 85°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 V , $R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$		5	7		V/ μs
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		
Φ_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 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 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	$f = 1\text{ kHz}$, $R_S = 100\ \Omega$			4.5		nV/ $\sqrt{\text{Hz}}$
I_n	Equivalent input noise current	$f = 1\text{ kHz}$			0.5		pA/ $\sqrt{\text{Hz}}$

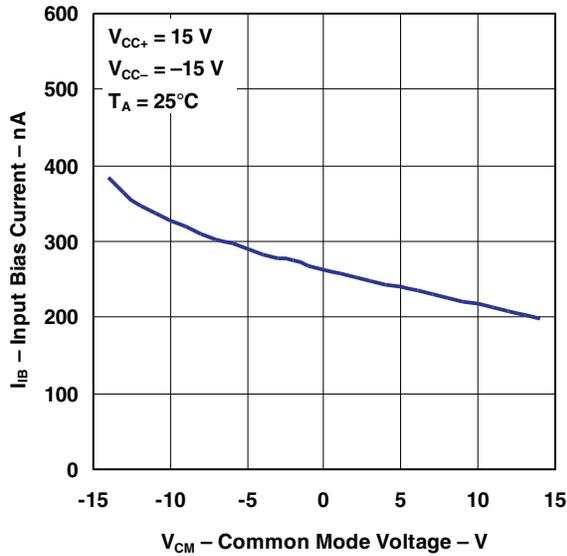


NOTE: All capacitors are non-polarized.

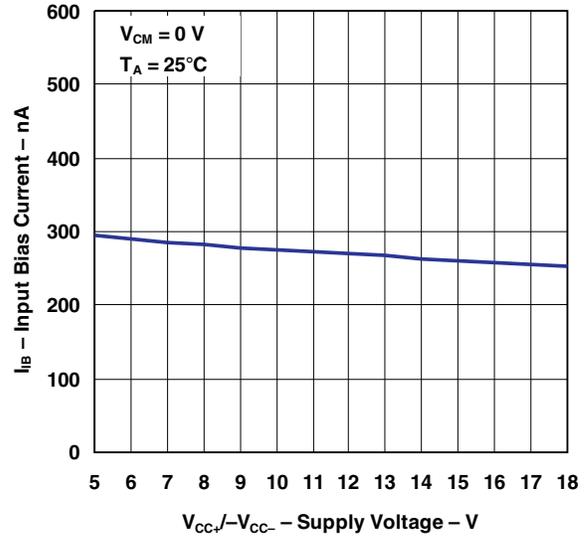
Figure 1. Voltage Noise Test Circuit (0.1 Hz to 10 Hz)

TYPICAL CHARACTERISTICS

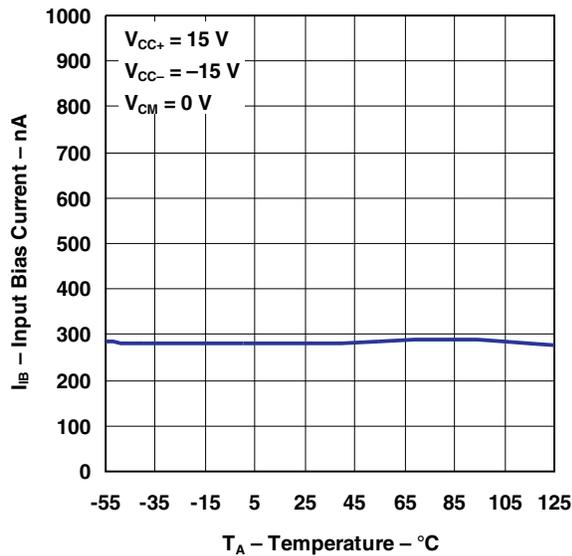
INPUT BIAS CURRENT
 VS
COMMON-MODE VOLTAGE



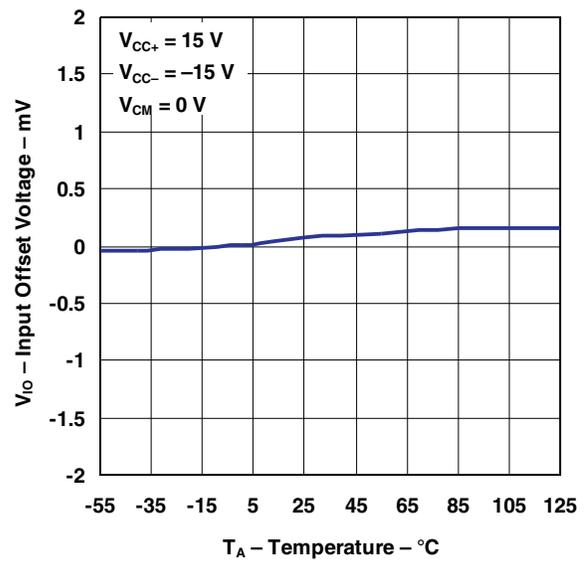
INPUT BIAS CURRENT
 VS
SUPPLY VOLTAGE



INPUT BIAS CURRENT
 VS
TEMPERATURE

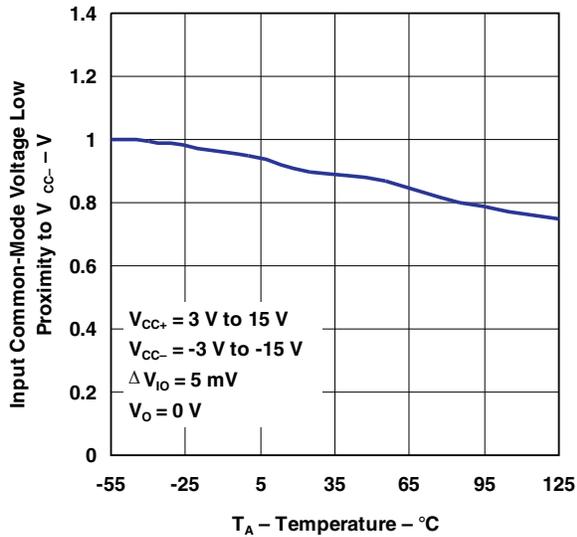


INPUT OFFSET VOLTAGE
 VS
TEMPERATURE

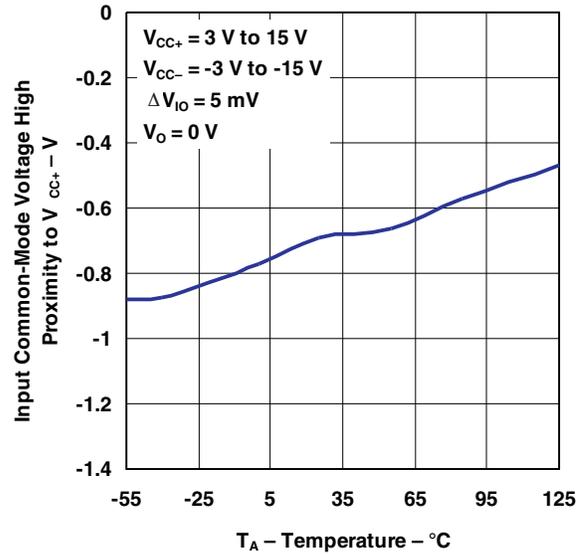


TYPICAL CHARACTERISTICS (continued)

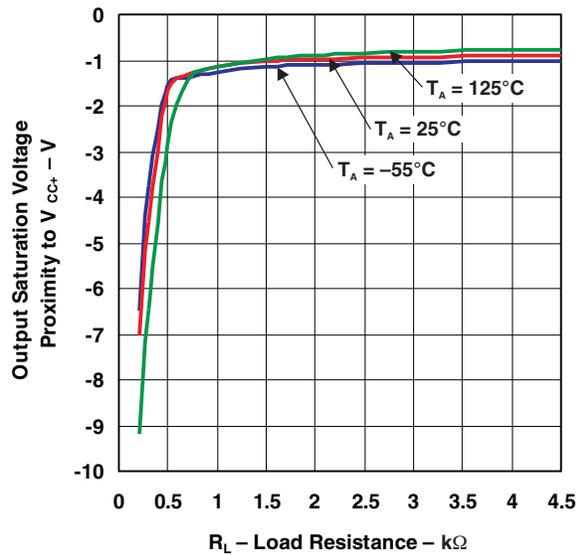
INPUT COMMON-MODE VOLTAGE
 LOW PROXIMITY TO V_{CC-}
 VS
 TEMPERATURE



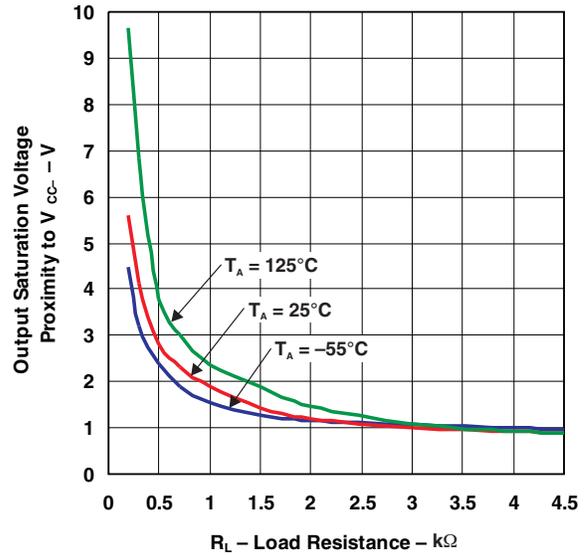
INPUT COMMON-MODE VOLTAGE
 HIGH PROXIMITY TO V_{CC+}
 VS
 TEMPERATURE



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

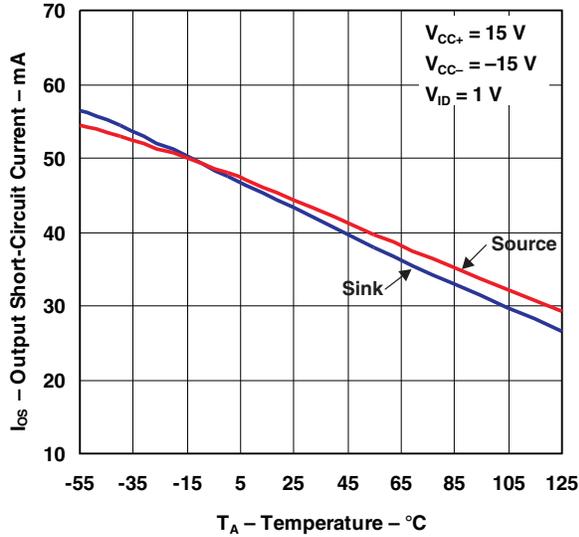


OUTPUT SATURATION VOLTAGE PROXIMITY TO V_{CC-}
 VS
 LOAD RESISTANCE

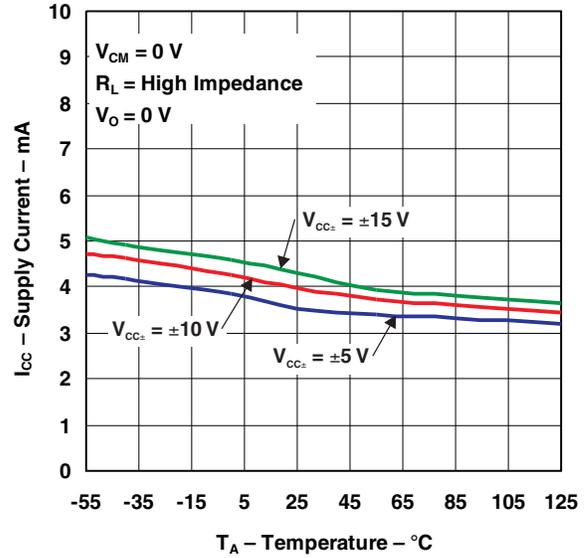


TYPICAL CHARACTERISTICS (continued)

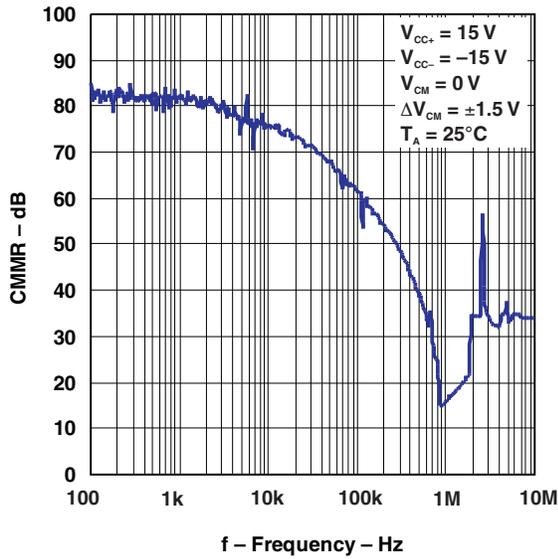
**OUTPUT SHORT-CIRCUIT CURRENT
VS
TEMPERATURE**



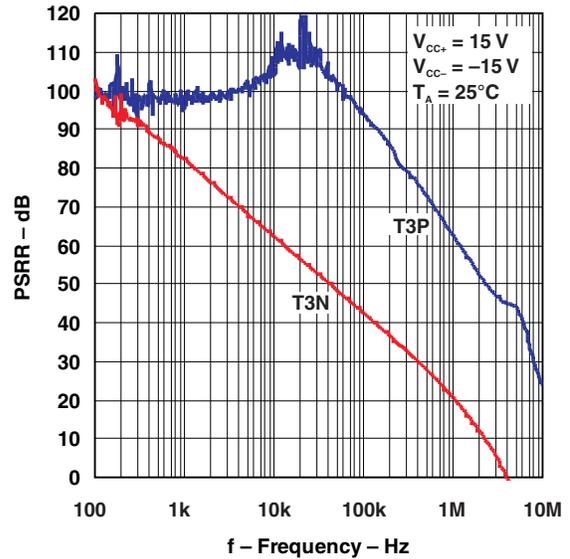
**SUPPLY CURRENT
VS
TEMPERATURE**



**CMRR
VS
FREQUENCY**

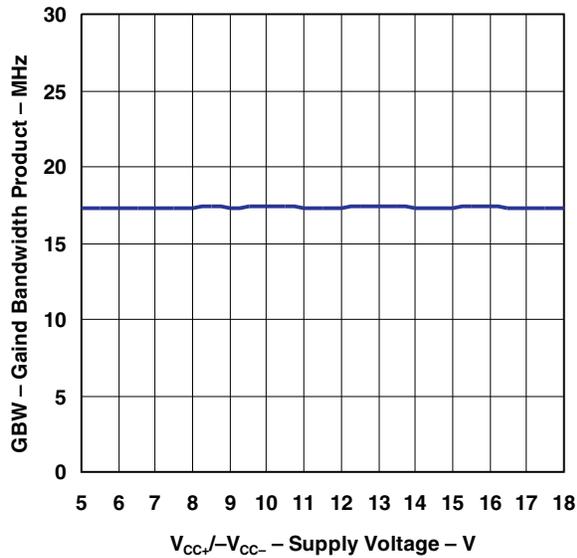


**PSSR
VS
FREQUENCY**

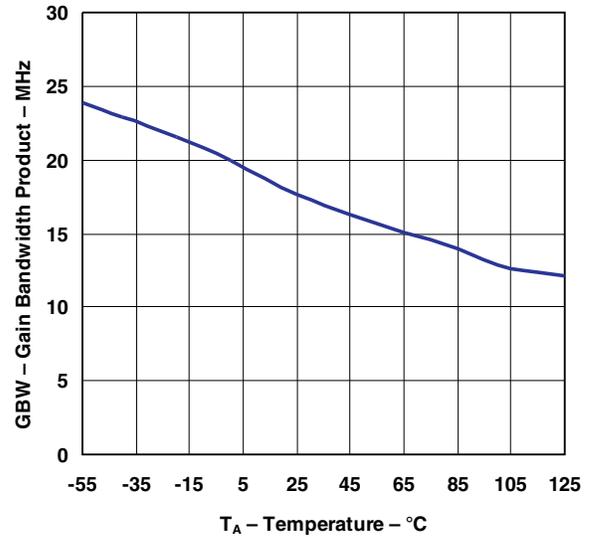


TYPICAL CHARACTERISTICS (continued)

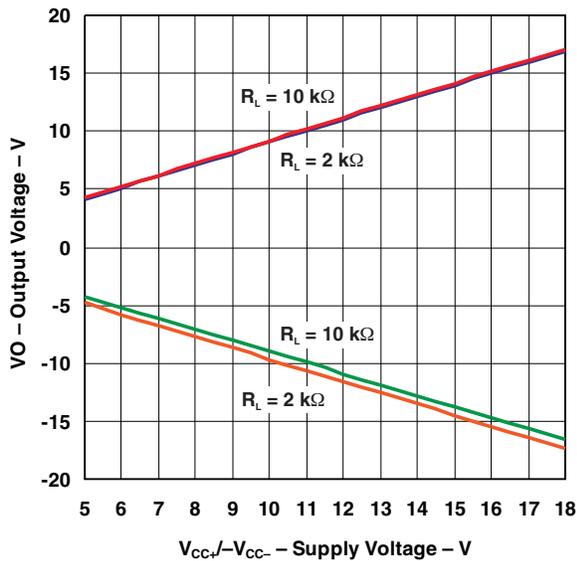
GAIN BANDWIDTH PRODUCT
 VS
 SUPPLY VOLTAGE



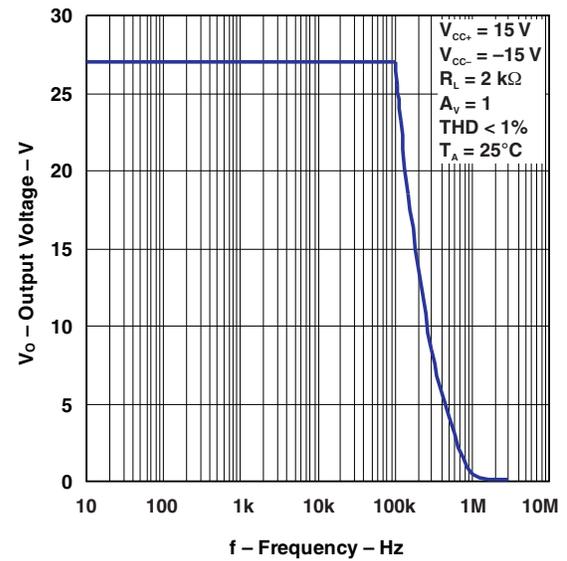
GAIN BANDWIDTH PRODUCT
 VS
 TEMPERATURE



OUTPUT VOLTAGE
 VS
 SUPPLY VOLTAGE

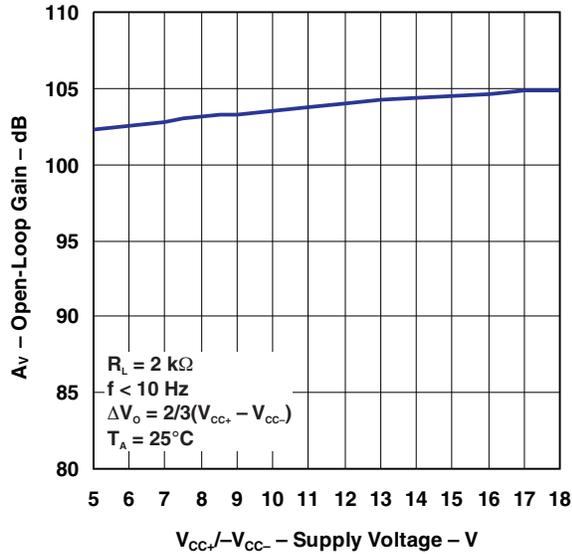


OUTPUT VOLTAGE
 VS
 FREQUENCY

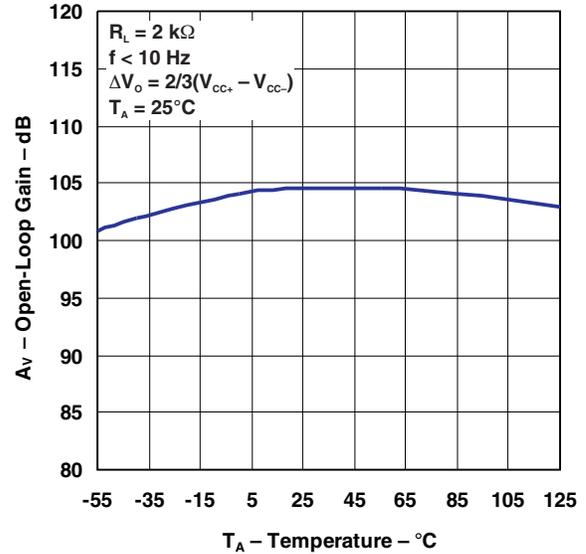


TYPICAL CHARACTERISTICS (continued)

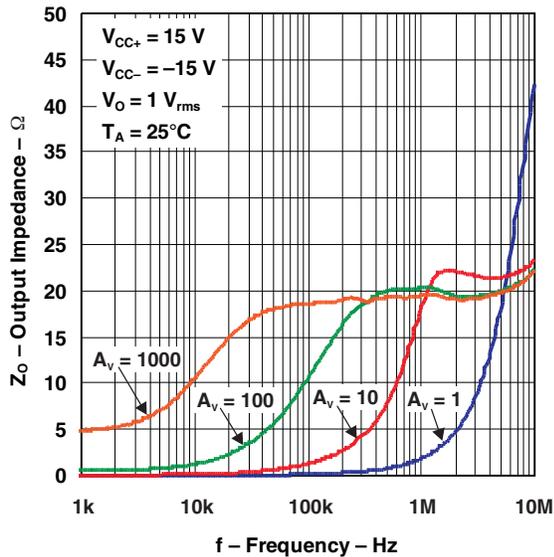
**OPEN-LOOP GAIN
VS
SUPPLY VOLTAGE**



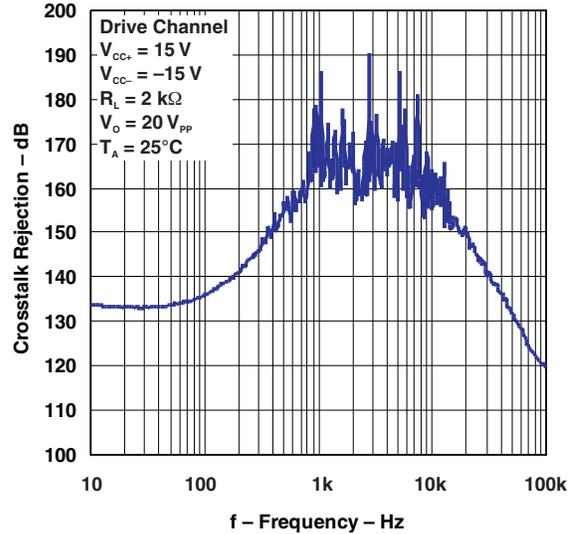
**OPEN-LOOP GAIN
VS
TEMPERATURE**



**OUTPUT IMPEDANCE
VS
FREQUENCY**

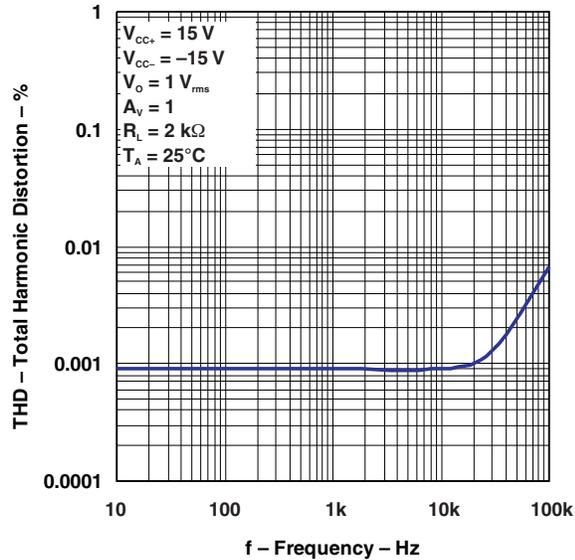


**CROSSTALK REJECTION
VS
FREQUENCY**

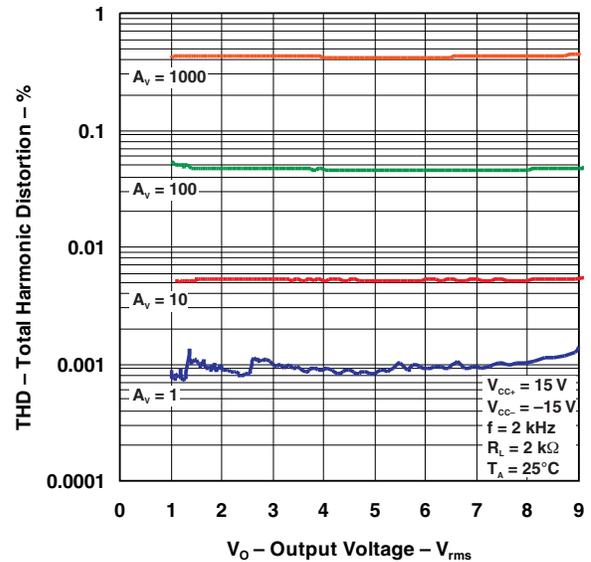


TYPICAL CHARACTERISTICS (continued)

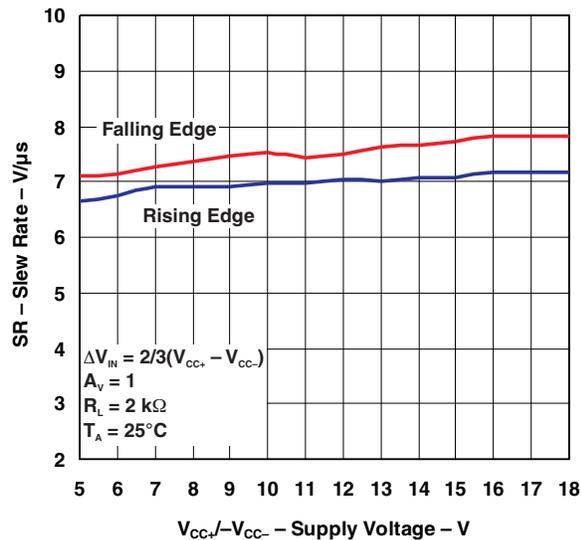
TOTAL HARMONIC DISTORTION
 VS
 FREQUENCY



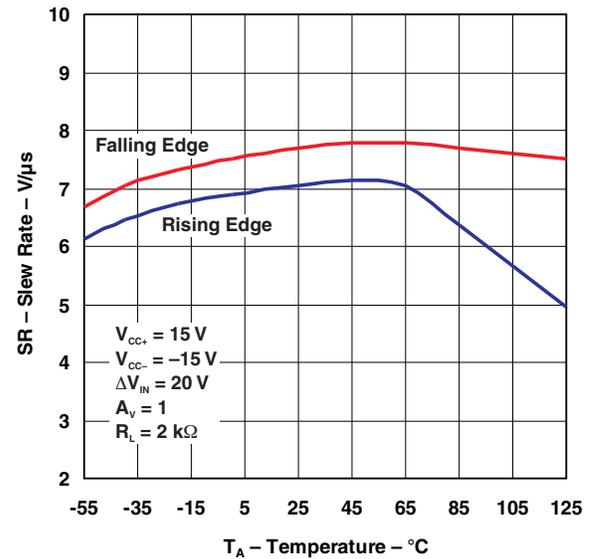
TOTAL HARMONIC DISTORTION
 VS
 OUTPUT VOLTAGE



SLEW RATE
 VS
 SUPPLY VOLTAGE

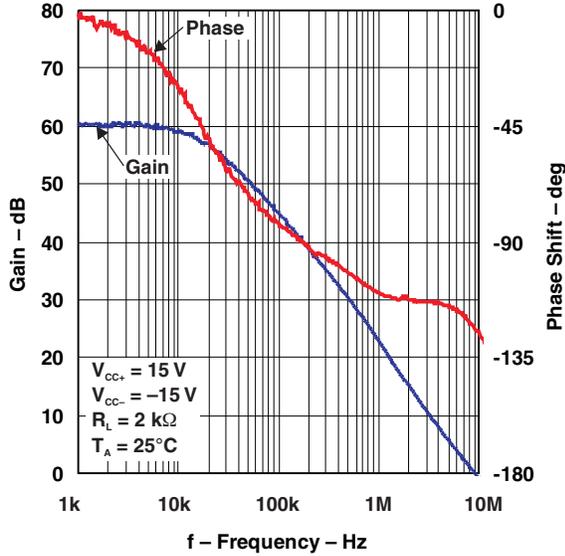


SLEW RATE
 VS
 TEMPERATURE

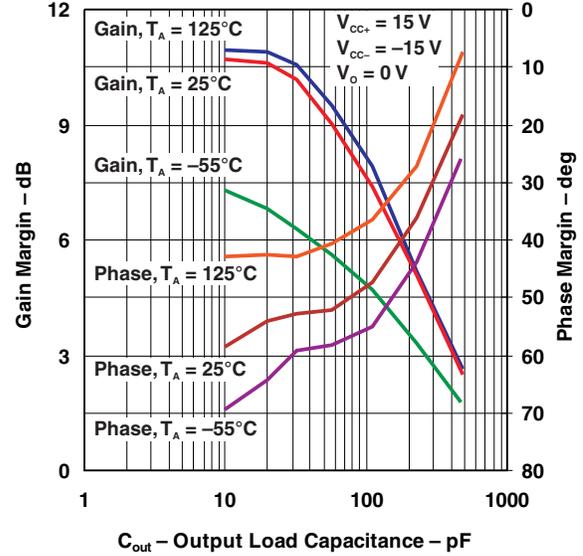


TYPICAL CHARACTERISTICS (continued)

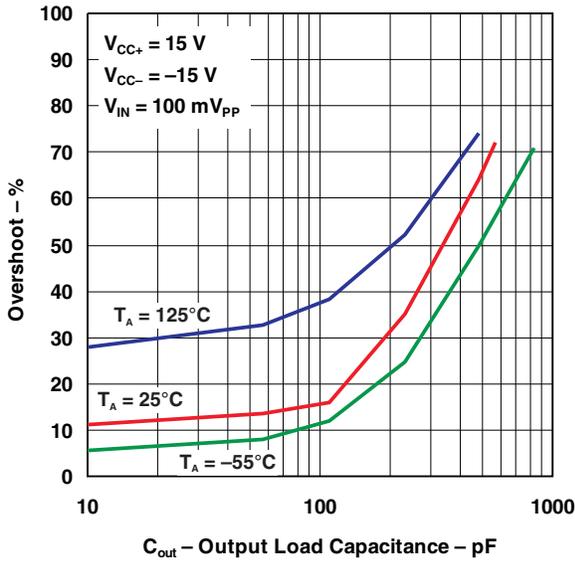
GAIN AND PHASE VS FREQUENCY



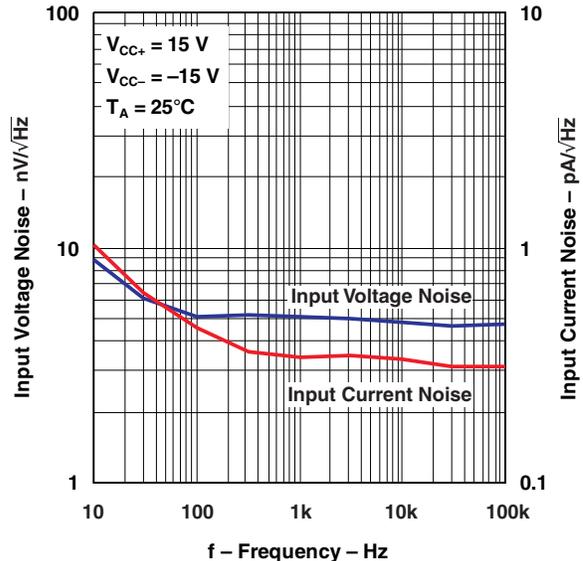
GAIN AND PHASE MARGIN VS OUTPUT LOAD CAPACITANCE



OVERSHOOT VS OUTPUT LOAD CAPACITANCE

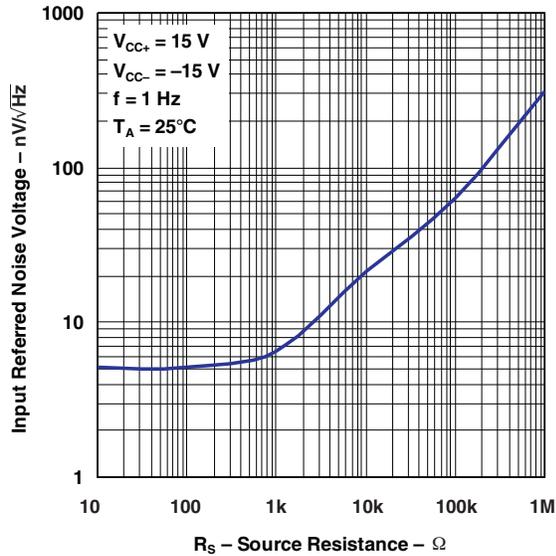


INPUT VOLTAGE AND CURRENT NOISE VS FREQUENCY

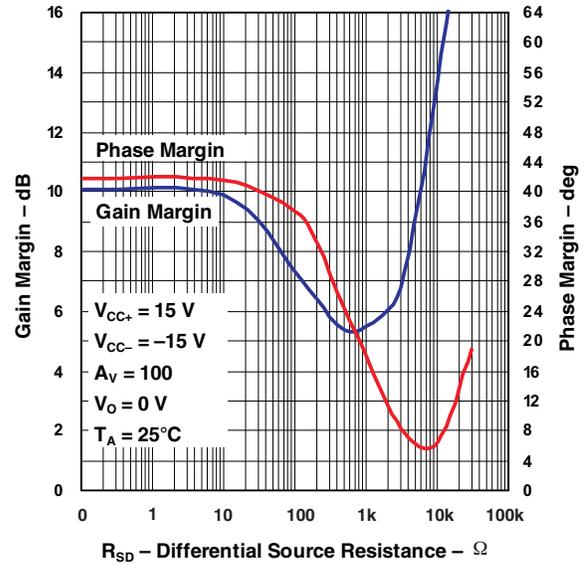


TYPICAL CHARACTERISTICS (continued)

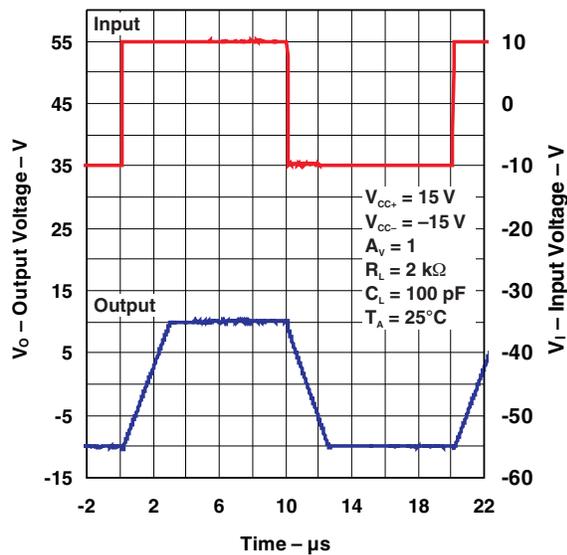
INPUT REFERRED NOISE VOLTAGE
 VS
 SOURCE RESISTANCE



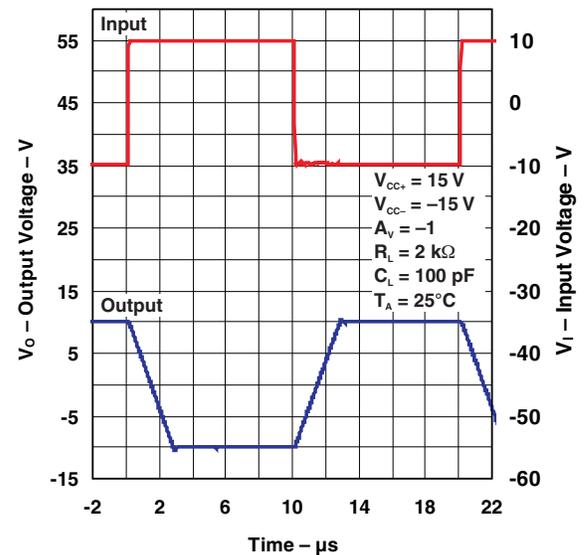
GAIN AND PHASE MARGIN
 VS
 DIFFERENTIAL SOURCE RESISTANCE



LARGE SIGNAL TRANSIENT RESPONSE
 (AV = 1)

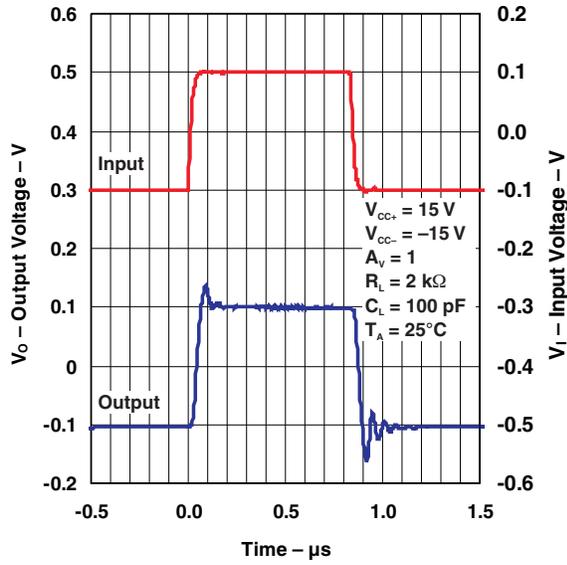


LARGE SIGNAL TRANSIENT RESPONSE
 (AV = -1)

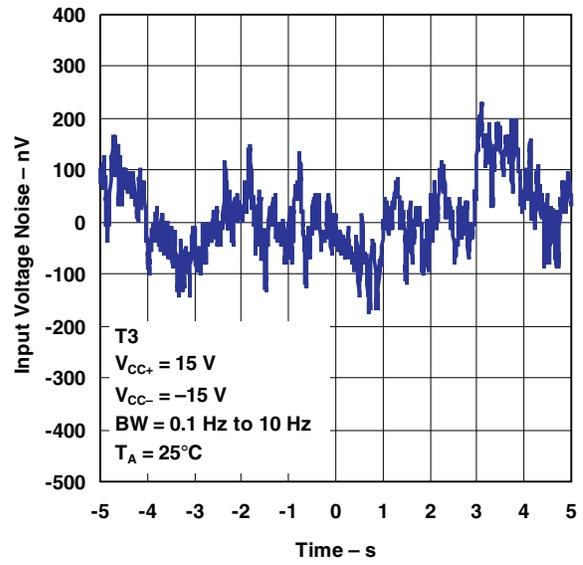


TYPICAL CHARACTERISTICS (continued)

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).

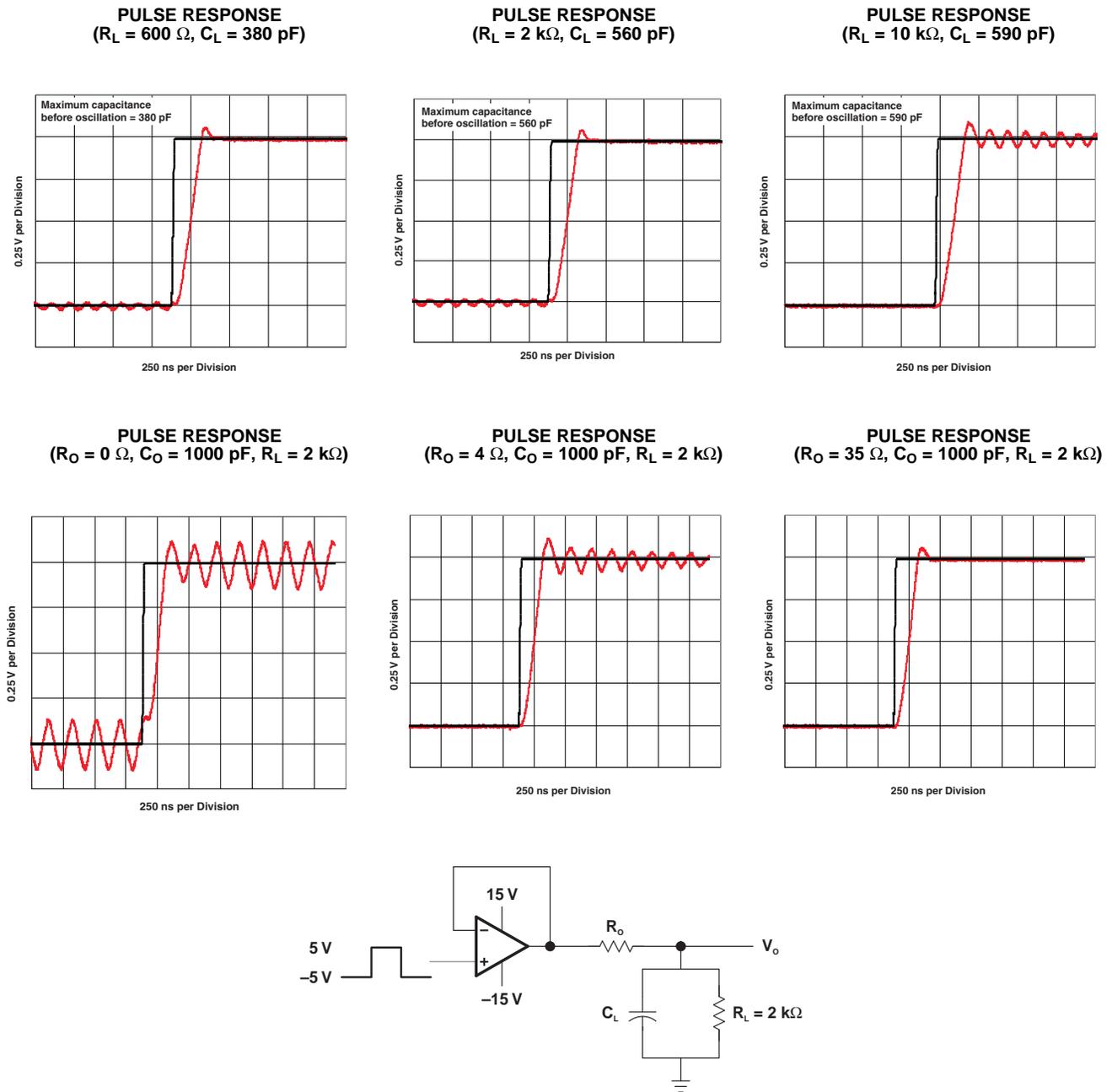


Figure 2. Output Characteristics

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
MC33078D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	M33078	Samples
MC33078DG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	M33078	Samples
MC33078DGKR	ACTIVE	VSSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MYU	Samples
MC33078DGKRG4	ACTIVE	VSSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MYU	Samples
MC33078DGKT	ACTIVE	VSSOP	DGK	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MYU	Samples
MC33078DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	M33078	Samples
MC33078DRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	M33078	Samples
MC33078P	ACTIVE	PDIP	P	8	50	Green (RoHS & no Sb/Br)	CU 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.

OBSELETE: 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/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 :

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

NOTE: Qualified Version Definitions:

- Enhanced Product - Supports Defense, Aerospace and Medical Applications

TAPE AND REEL INFORMATION

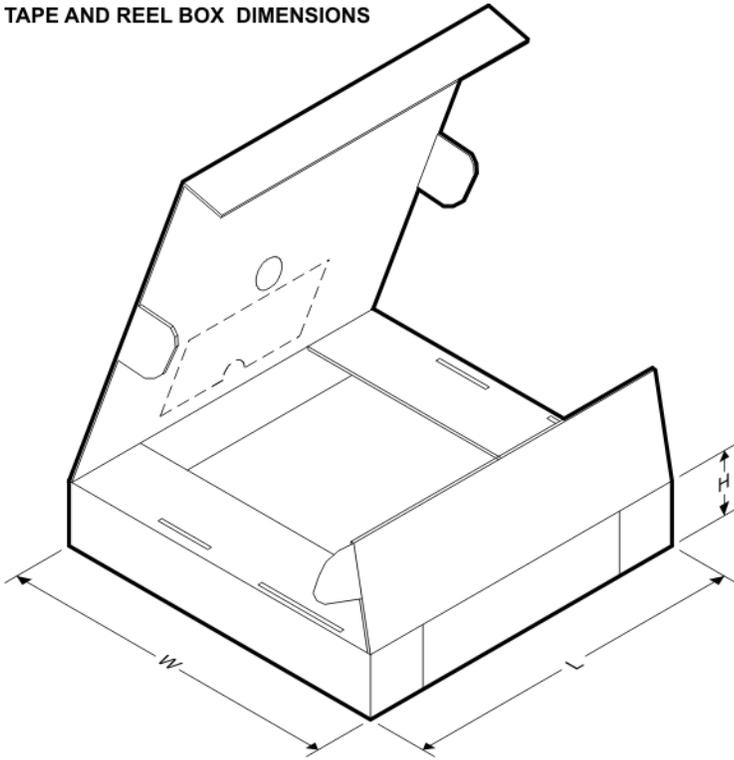


QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

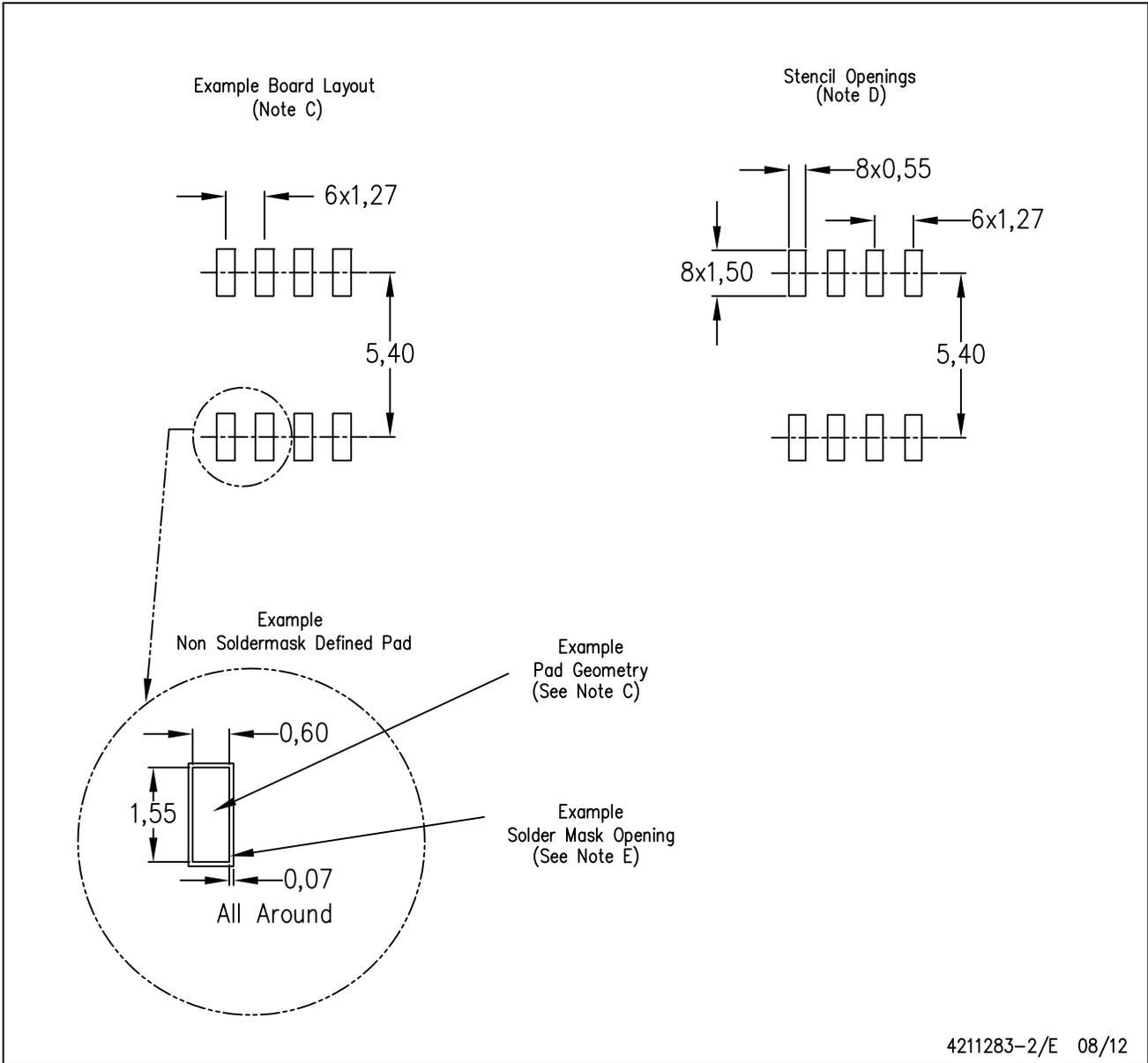
TAPE AND REEL BOX DIMENSIONS


*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	220.0	205.0	50.0
MC33078DR	SOIC	D	8	2500	340.5	338.1	20.6
MC33078DR	SOIC	D	8	2500	367.0	367.0	35.0

D (R-PDSO-G8)

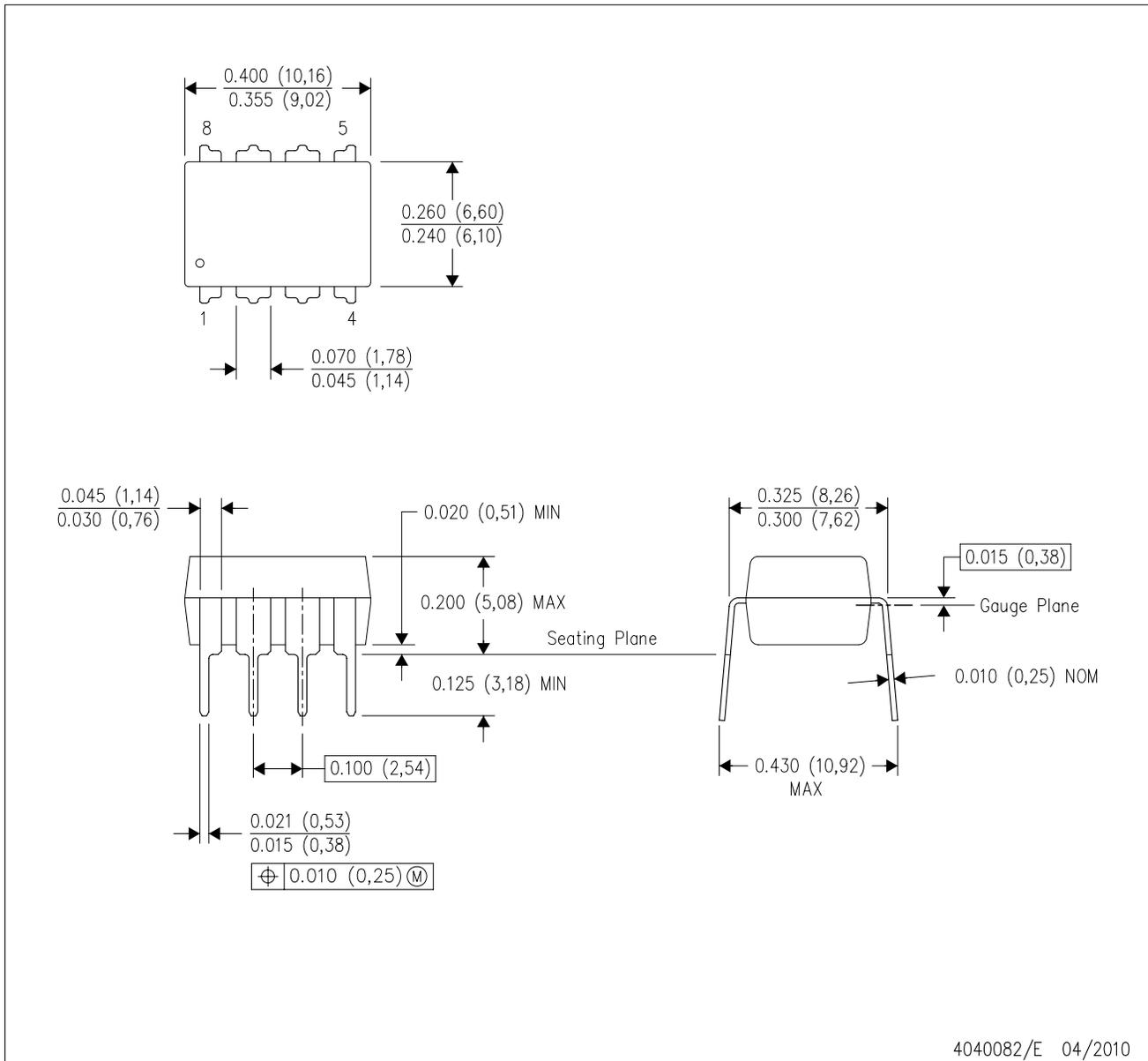
PLASTIC SMALL OUTLINE



- 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.

P (R-PDIP-T8)

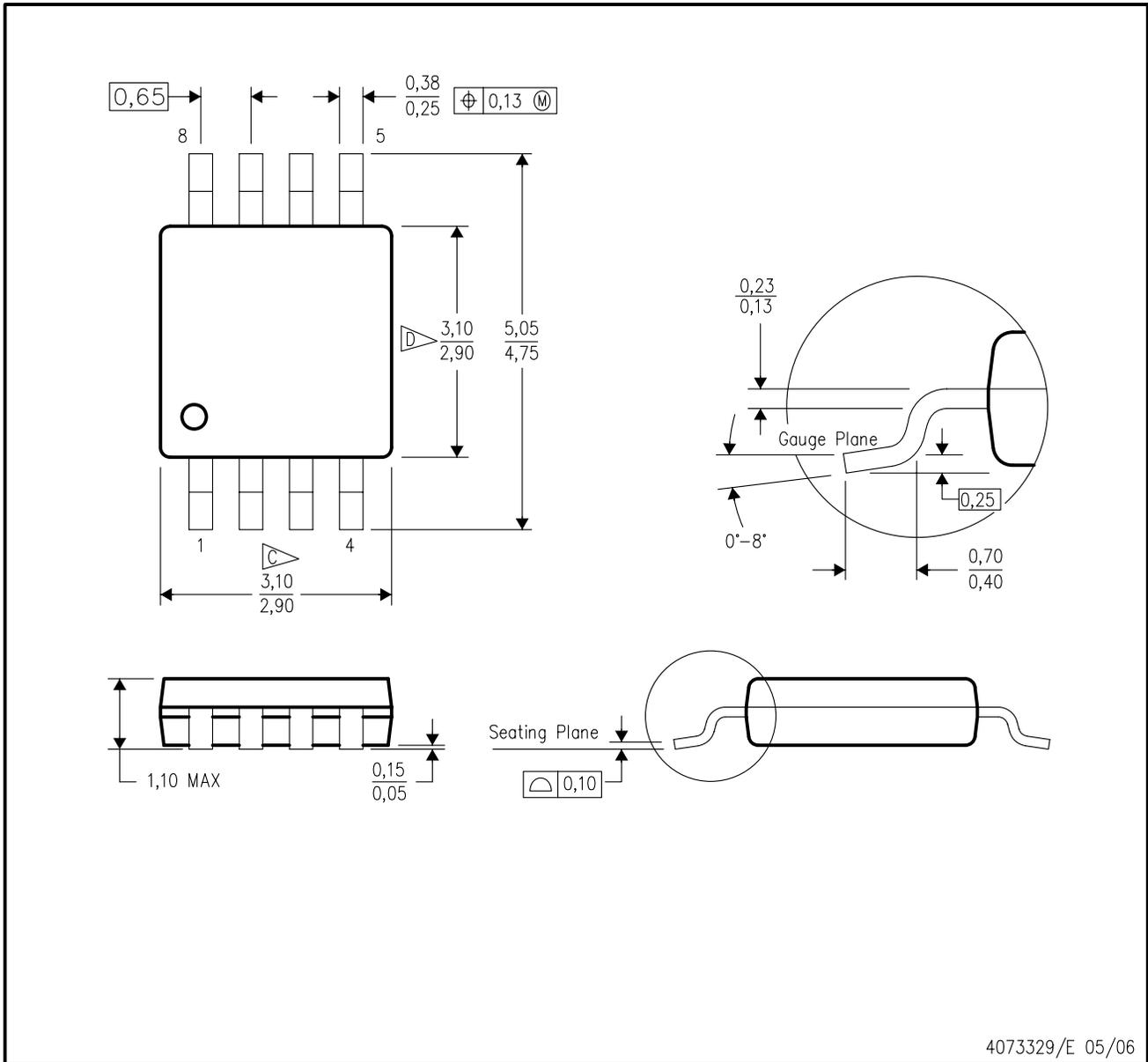
PLASTIC DUAL-IN-LINE PACKAGE



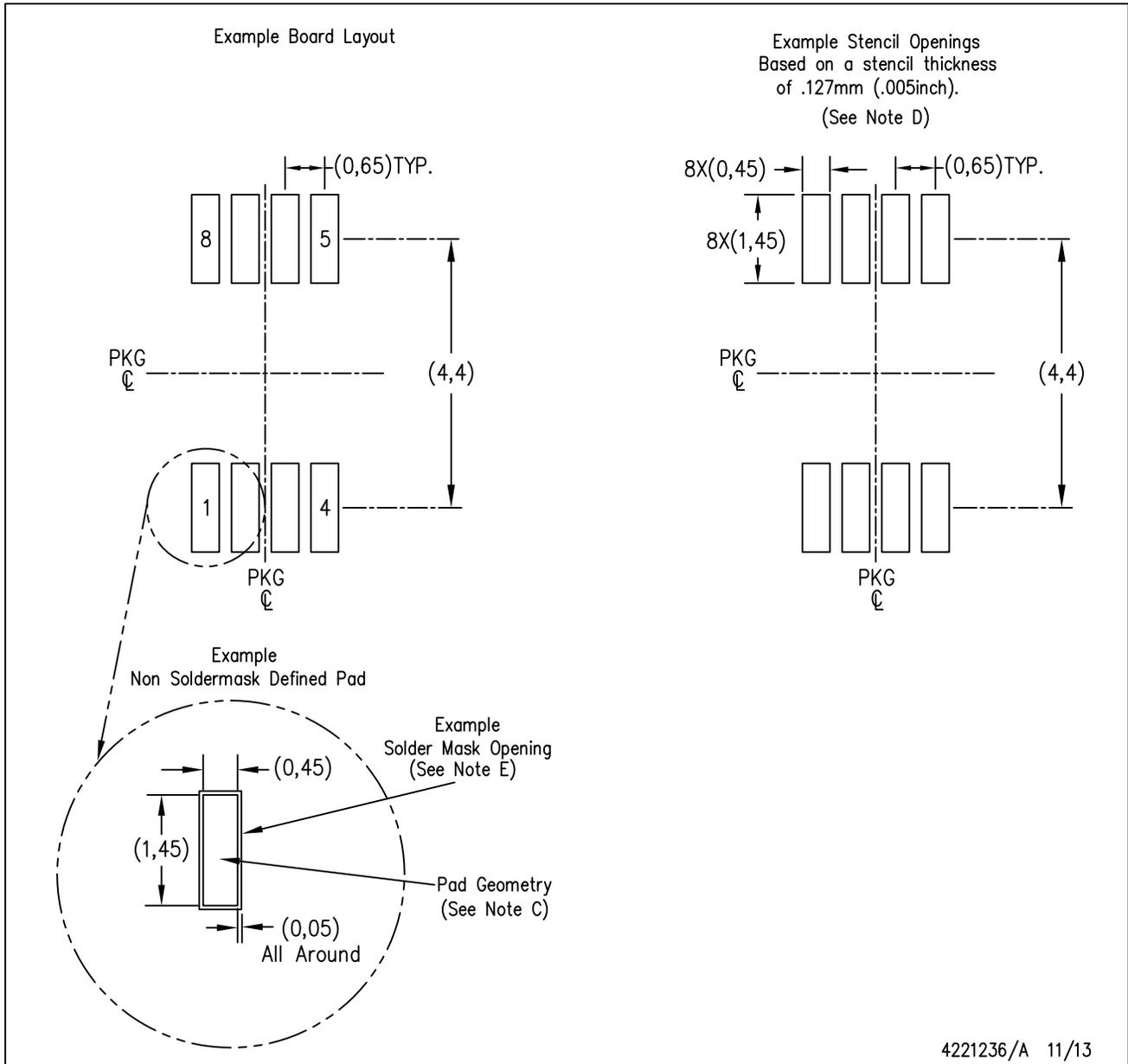
- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Falls within JEDEC MS-001 variation BA.

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.

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