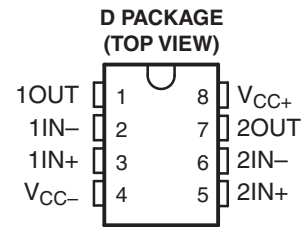


## FEATURES

- Qualified for Automotive Applications
- Low Power Consumption
- Wide Common-Mode and Differential Voltage Ranges
- Low Input Bias and Offset Currents
- Low Total Harmonic Distortion: 0.003% Typ
- High Input Impedance: JFET-Input Stage
- Latchup-Free Operation
- High Slew Rate: 13 V/μs Typ
- Common-Mode Input Voltage Range Includes  $V_{CC+}$



## DESCRIPTION/ORDERING INFORMATION

The TL082 JFET-input operational amplifier incorporates well-matched, high-voltage JFET and bipolar transistors in a monolithic integrated circuit. The device features high slew rates, low input bias and offset currents, and low offset-voltage temperature coefficient.

The I-suffix device is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The Q-suffix device is characterized for operation from  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

### ORDERING INFORMATION<sup>(1)</sup>

$T_J$	PACKAGE <sup>(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
$-40^{\circ}\text{C}$ to $85^{\circ}\text{C}$	SOIC – D	Reel of 2500	TL082IDRQ1	TL082I
$-40^{\circ}\text{C}$ to $125^{\circ}\text{C}$	SOIC – D	Reel of 2500	TL082QDRQ1	TL082Q

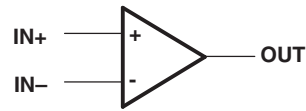
(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at [www.ti.com](http://www.ti.com).

(2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

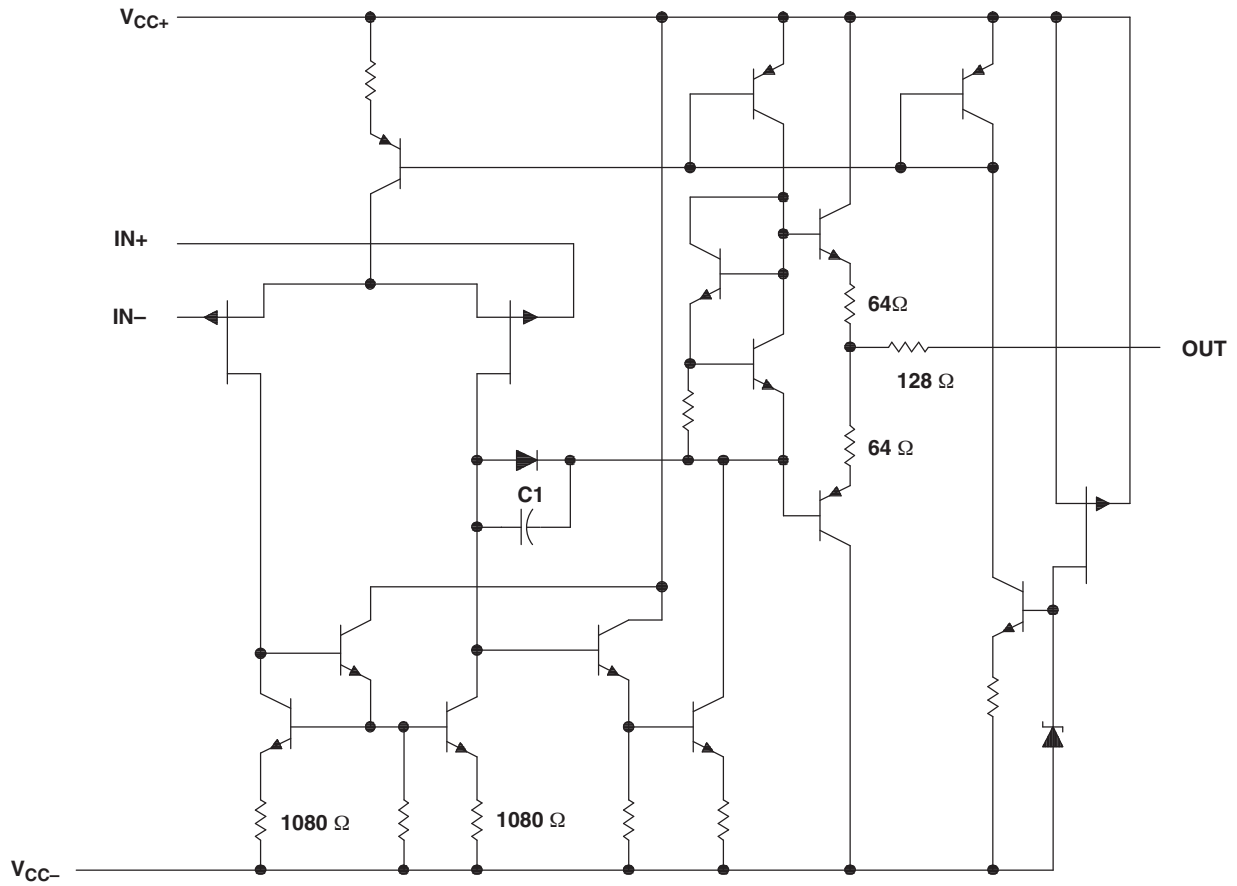


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

**SYMBOL (EACH AMPLIFIER)**



**SCHEMATIC (EACH AMPLIFIER)**



A. Component values shown are nominal.

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

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

		VALUE	
V <sub>CC+</sub>	Supply voltage, positive <sup>(2)</sup>	18 V	
V <sub>CC-</sub>	Supply voltage, negative <sup>(2)</sup>	–18 V	
V <sub>ID</sub>	Differential input voltage <sup>(3)</sup>	±30 V	
V <sub>I</sub>	Input voltage <sup>(2)(4)</sup>	±15 V	
	Duration of output short circuit <sup>(5)</sup>	Unlimited	
	Continuous total power dissipation	<sup>(6)</sup>	
T <sub>A</sub>	Operating free-air temperature range	TL082I	–40°C to 85°C
		TL082Q	–40°C to 125°C
θ <sub>JA</sub>	Package thermal impedance, junction to free air <sup>(7)</sup>		97°C/W
ESD rating <sup>(8)</sup>		Human-Body Model	1.5 kV (H1C)
		Charged-Device Model	1.5 kV (C5)
		Machine Model	200 V (M3)
	Operating virtual junction temperature		150°C
T <sub>stg</sub>	Storage temperature range		–65°C to 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) Differential voltages are at IN+ with respect to IN–.
- (4) The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 V, whichever is less.
- (5) The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the 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 PD = (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.
- (8) ESD protection level per JEDEC classifications JESD22-A114 (HBM), JESD22-A115 (MM), and JESD22-C101 (CDM).

**ELECTRICAL CHARACTERISTICS<sup>(1)</sup>**

$V_{CC\pm} = \pm 15\text{ V}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	$T_A$ <sup>(2)</sup>	MIN	TYP	MAX	UNIT
$V_{IO}$	Input offset voltage	$V_O = 0, R_S = 50\ \Omega$	25°C		3	6	mV
			Full range			9	
$\alpha_{VIO}$	Temperature coefficient of input offset voltage	$V_O = 0, R_S = 50\ \Omega$	Full range		18		$\mu\text{V}/^\circ\text{C}$
$I_{IO}$	Input offset current <sup>(3)</sup>	$V_O = 0$	25°C		5	100	pA
			Full range			20	nA
$I_{IB}$	Input bias current <sup>(3)</sup>	$V_O = 0$	25°C		30	200	pA
			Full range			50	nA
$V_{ICR}$	Common-mode input voltage range		25°C	$\pm 11$	-12 to 15		V
$V_{OM}$	Maximum peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	$\pm 12$	$\pm 13.5$		V
		$R_L \geq 10\ \text{k}\Omega$	Full range	$\pm 12$			
		$R_L \geq 2\ \text{k}\Omega$		$\pm 10$	$\pm 12$		
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 10\ \text{V}, R_L \geq 2\ \text{k}\Omega$	25°C	50	200		V/mV
			Full range	15			
B1	Unity-gain bandwidth		25°C		3		MHz
$r_i$	Input resistance		25°C		$10^{12}$		$\Omega$
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}(\text{min}), V_O = 0, R_S = 50\ \Omega$	25°C	75	86		dB
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ )	$V_{CC} = \pm 15\ \text{V}$ to $\pm 9\ \text{V}, V_O = 0, R_S = 50\ \Omega$	25°C	80	86		dB
$I_{CC}$	Supply current (per amplifier)	$V_O = 0, \text{No load}$	25°C		1.4	2.8	mA
$V_{O1}/V_{O2}$	Crosstalk attenuation	$A_{VD} = 100$	25°C		120		dB

- (1) All characteristics are measured under open-loop conditions with zero common-mode voltage, unless otherwise specified.  
(2) Full range for  $T_A$  is  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  for I-suffix devices and  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for Q-suffix devices.  
(3) Input bias currents of an FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive, as shown in Figure 14. Pulse techniques must be used that maintain the junction temperature as close to the ambient temperature as possible.

**OPERATING CHARACTERISTICS**

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	$V_I = 10\ \text{V}, R_L = 2\ \text{k}\Omega, C_L = 100\ \text{pF}$ , See Figure 1	8	13		$\text{V}/\mu\text{s}$
$t_r$	Rise time	$V_I = 20\ \text{mV}, R_L = 2\ \text{k}\Omega, C_L = 100\ \text{pF}$ , See Figure 1		0.05		$\mu\text{s}$
	Overshoot factor	$V_I = 20\ \text{mV}, R_L = 2\ \text{k}\Omega, C_L = 100\ \text{pF}$ , See Figure 1		20		%
$V_n$	Equivalent input noise voltage	$R_S = 20\ \Omega$	$f = 1\ \text{kHz}$		18	$\text{nV}/\sqrt{\text{Hz}}$
			$f = 10\ \text{Hz}$ to $10\ \text{kHz}$		4	$\mu\text{V}$
$I_n$	Equivalent input noise current	$R_S = 20\ \Omega, f = 1\ \text{kHz}$		0.01		$\text{pA}/\sqrt{\text{Hz}}$
THD	Total harmonic distortion	$V_{I\text{rms}} = 6\ \text{V}, f = 1\ \text{kHz}, \text{AVD} = 1, R_S \leq 1\ \text{k}\Omega, R_L \geq 2\ \text{k}\Omega$		0.003		%

PARAMETER MEASUREMENT INFORMATION

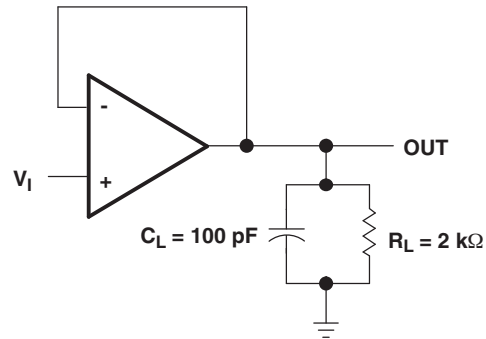


Figure 1.

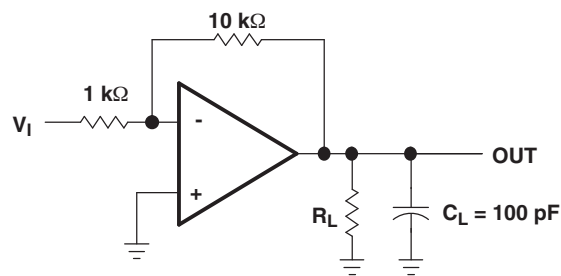


Figure 2.

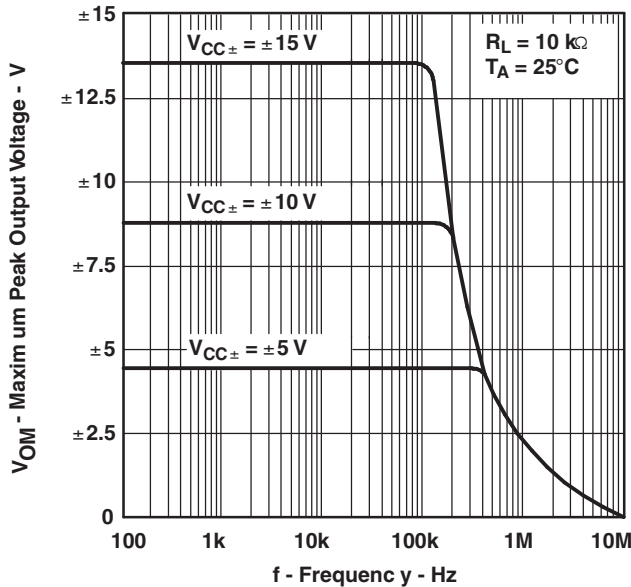
**TYPICAL CHARACTERISTICS**

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

**Table of Graphs**

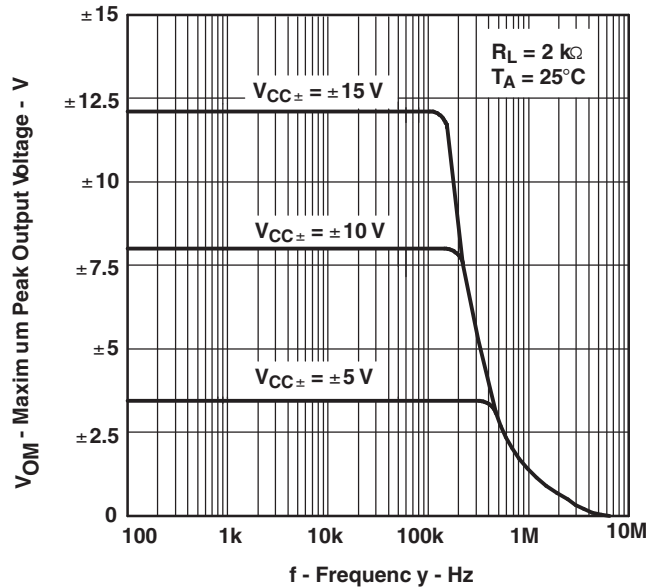
		<b>FIGURE</b>	
$V_{OM}$	Maximum peak output voltage	vs Frequency	3, 4, 5
		vs Free-air temperature	6
		vs Load resistance	7
		vs Supply voltage	8
$A_{VD}$	Large-signal differential voltage amplification	vs Free-air temperature	9
		vs Frequency	10
$P_D$	Total power dissipation	vs Free-air temperature	11
$I_{CC}$	Supply current	vs Free-air temperature	12
		vs Supply voltage	13
$I_{IB}$	Input bias current	vs Free-air temperature	14
		Large-signal pulse response	vs Time
$V_O$	Output voltage	vs Elapsed time	16
CMRR	Common-mode rejection ratio	vs Free-air temperature	17
$V_n$	Equivalent input noise voltage	vs Frequency	18
THD	Total harmonic distortion	vs Frequency	19

**MAXIMUM PEAK OUTPUT VOLTAGE**  
**vs**  
**FREQUENCY**  
(See Figure 2)



**Figure 3.**

**MAXIMUM PEAK OUTPUT VOLTAGE**  
**vs**  
**FREQUENCY**  
(See Figure 2)



**Figure 4.**

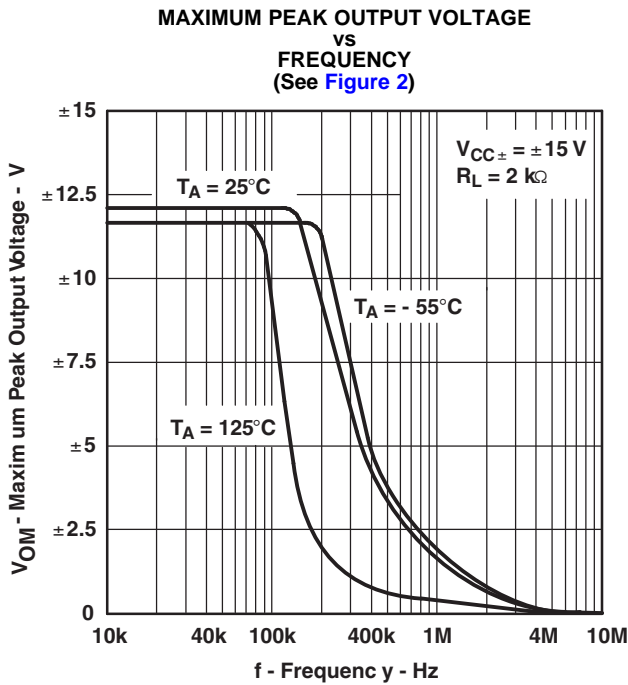


Figure 5.

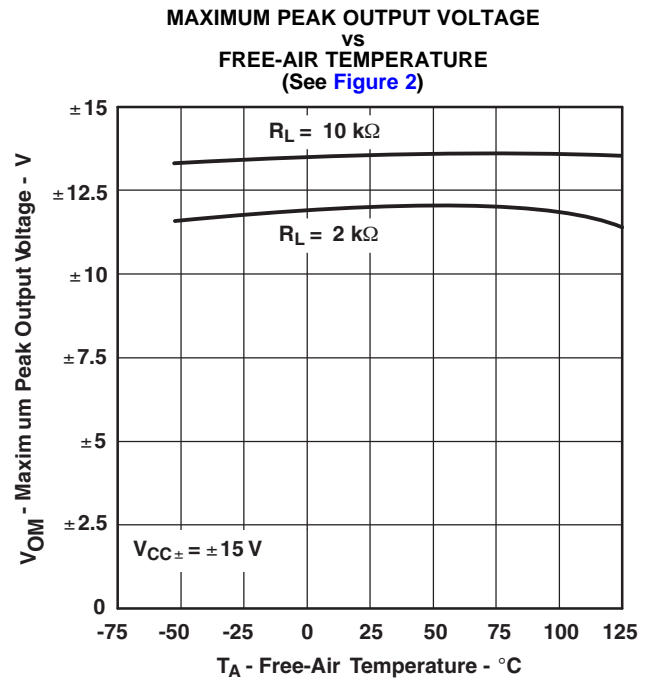


Figure 6.

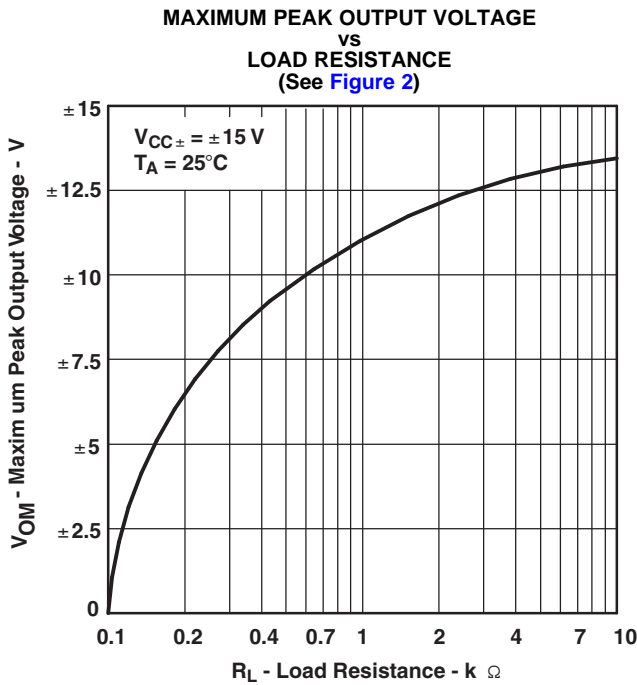


Figure 7.

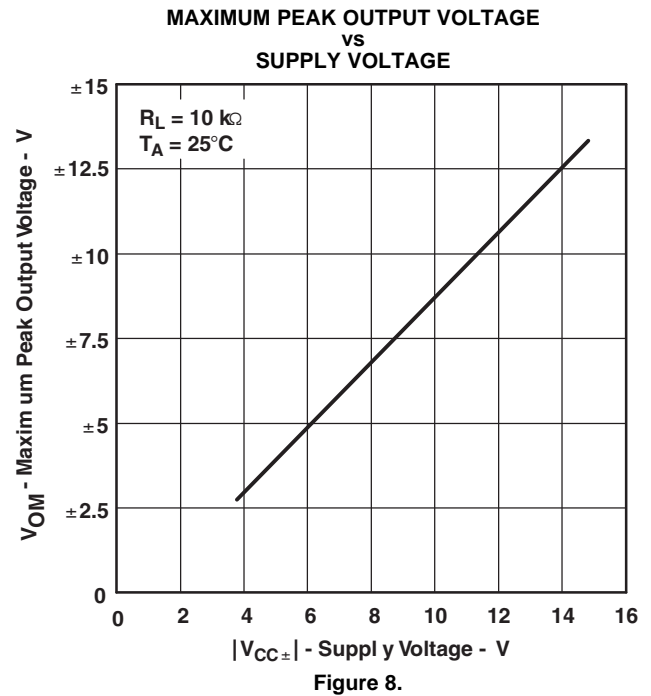


Figure 8.

**LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION  
 VS  
 FREE-AIR TEMPERATURE**

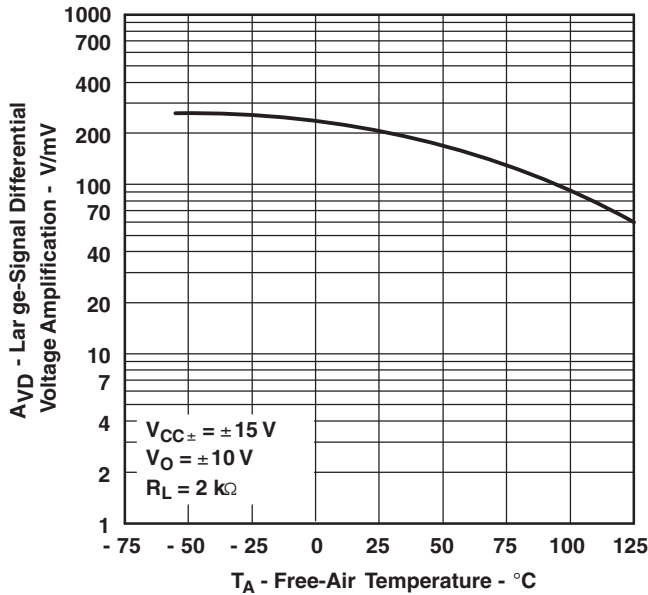


Figure 9.

**LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION  
 VS  
 FREQUENCY**

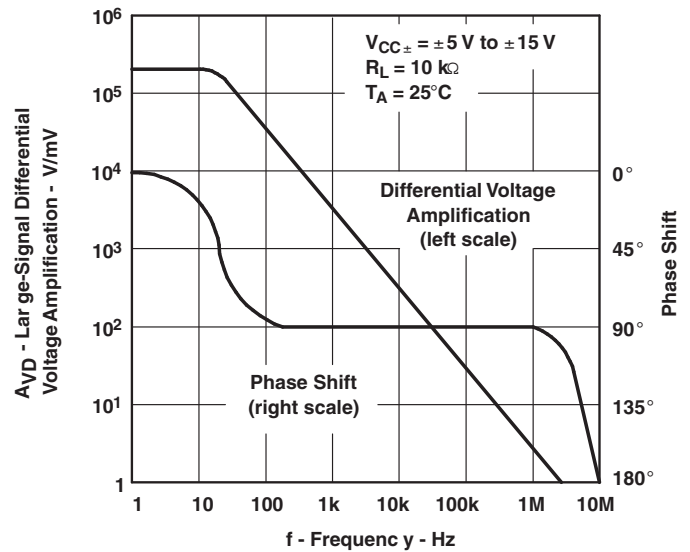


Figure 10.

**POWER DISSIPATION  
 VS  
 FREE-AIR TEMPERATURE**

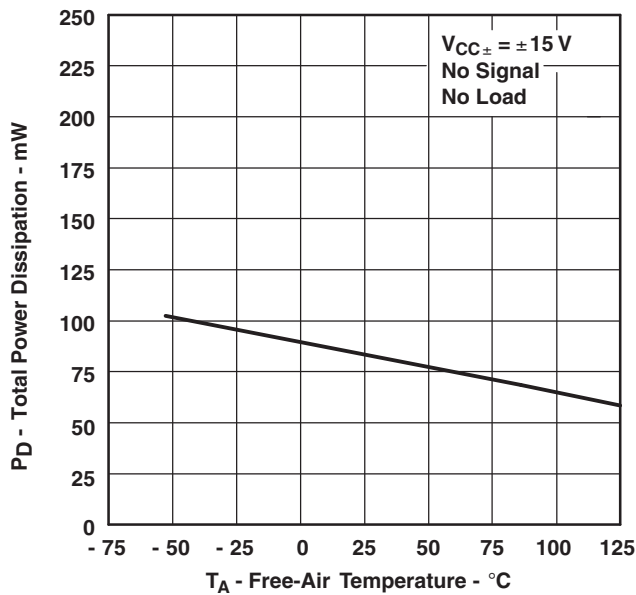


Figure 11.

**SUPPLY CURRENT  
 VS  
 FREE-AIR TEMPERATURE**

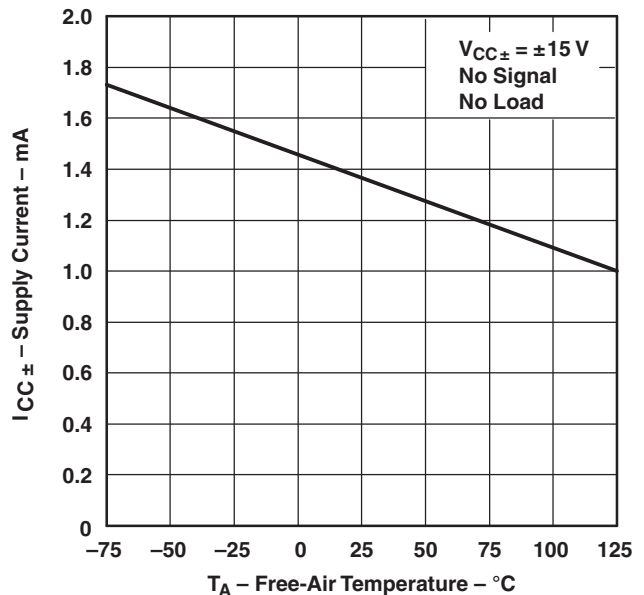


Figure 12.



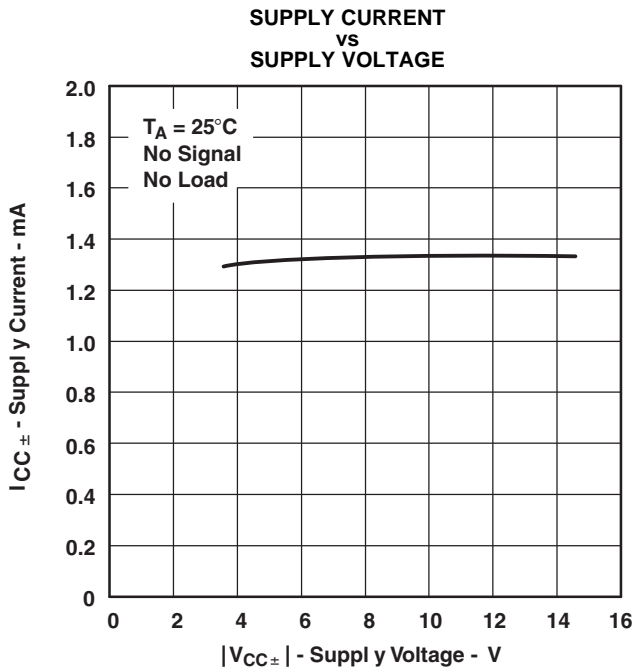


Figure 13.

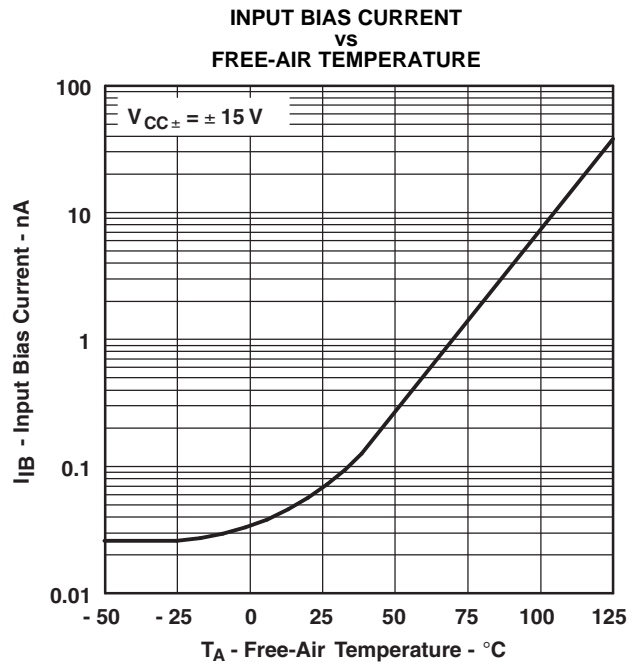


Figure 14.

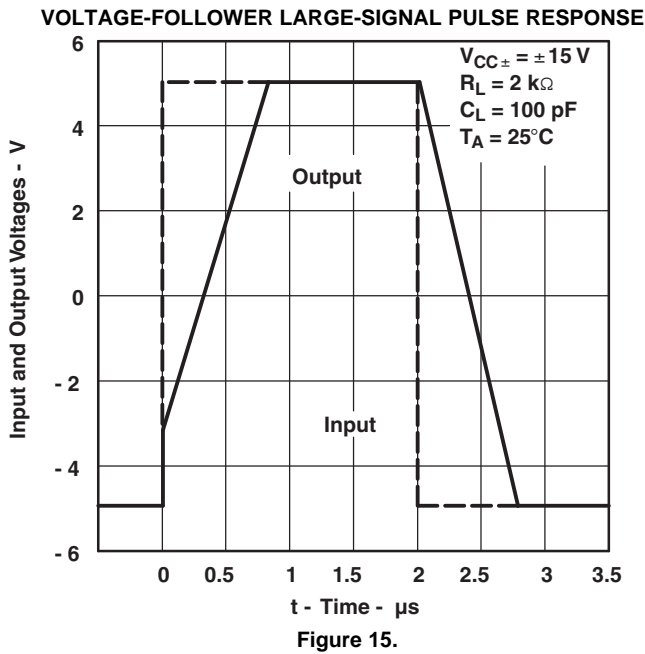


Figure 15.

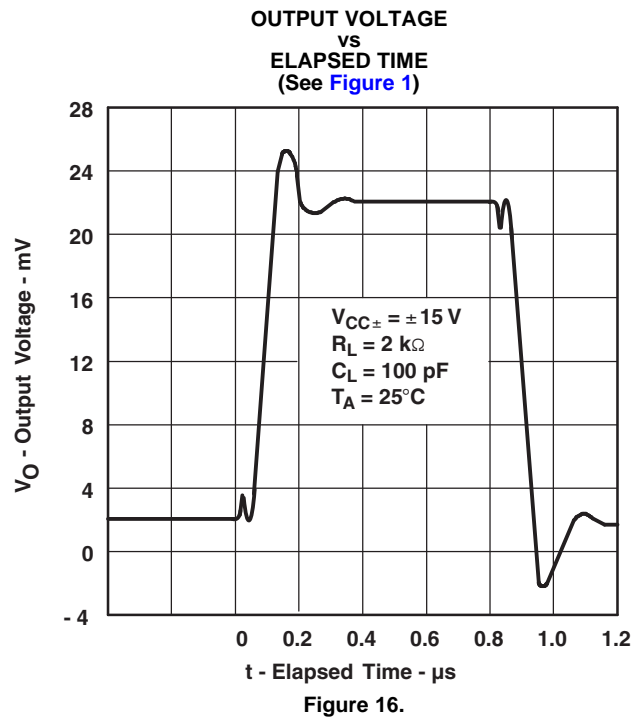


Figure 16.

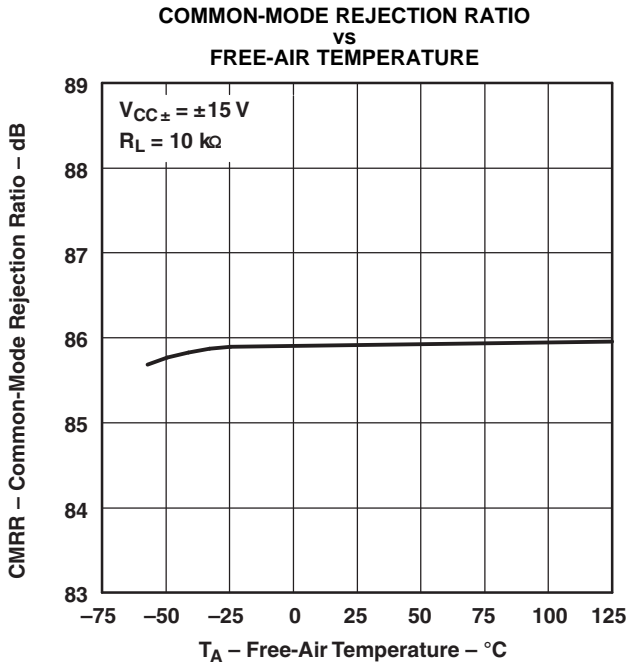


Figure 17.

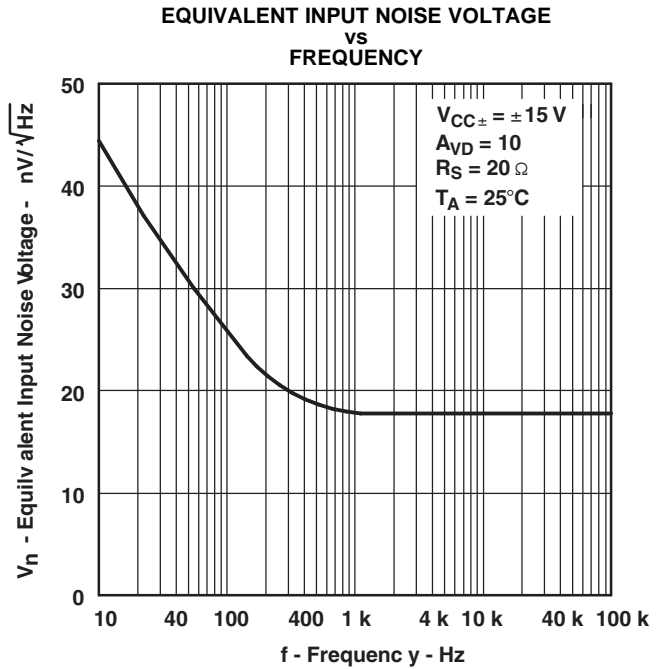


Figure 18.

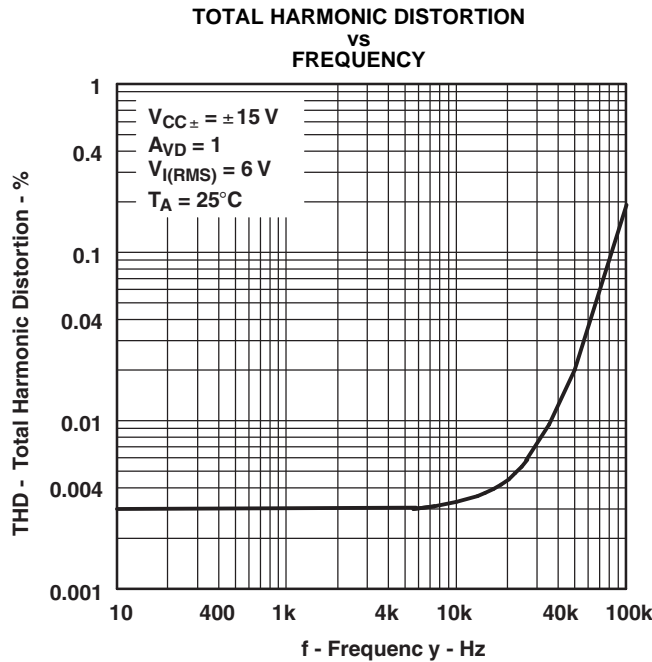


Figure 19.

APPLICATION INFORMATION

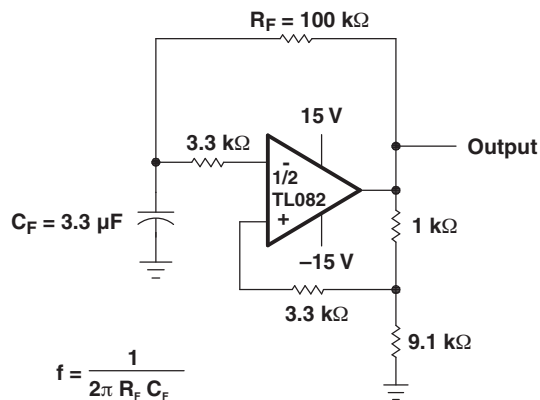


Figure 20.

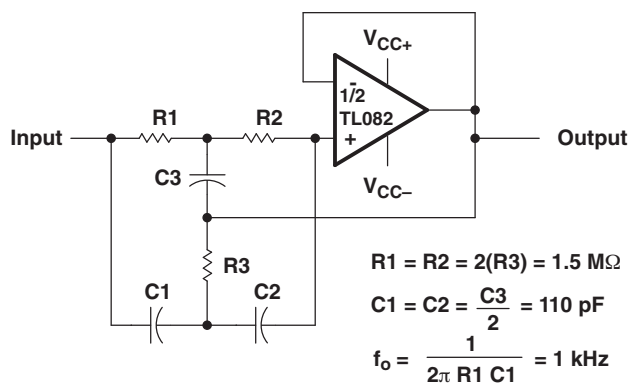


Figure 21.

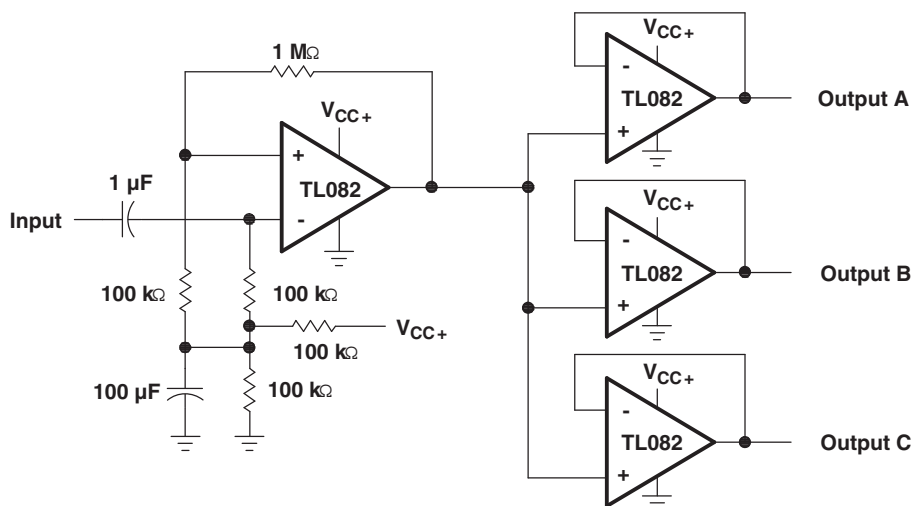
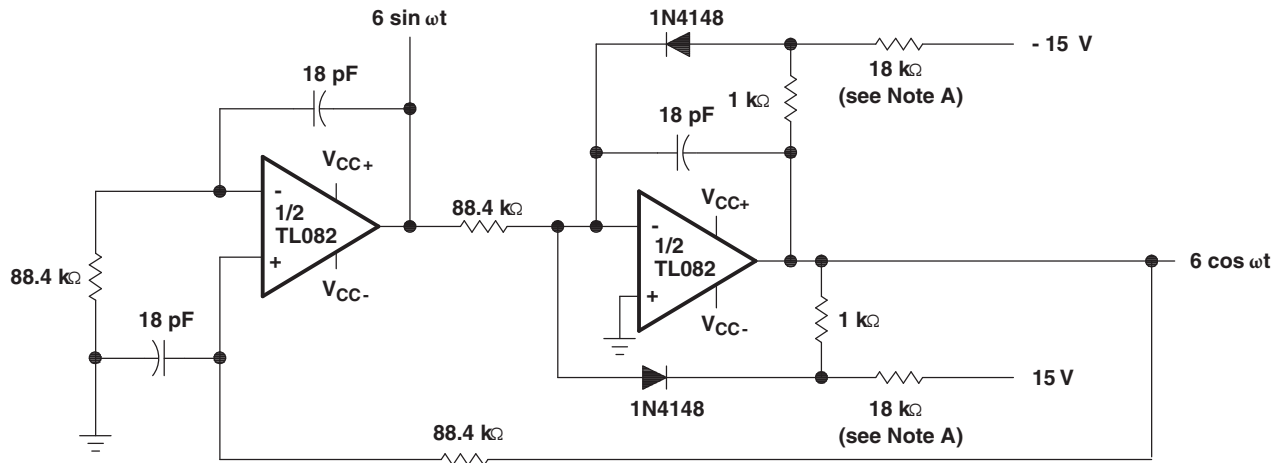
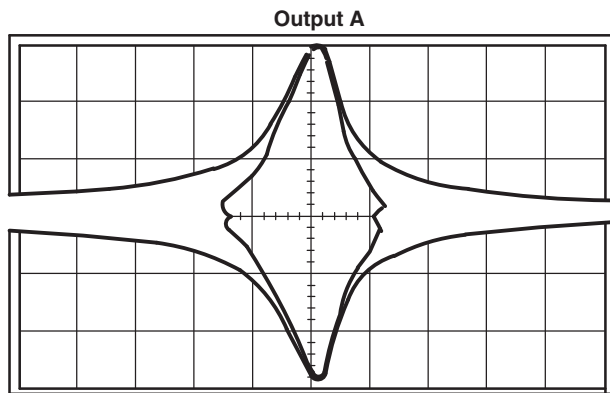
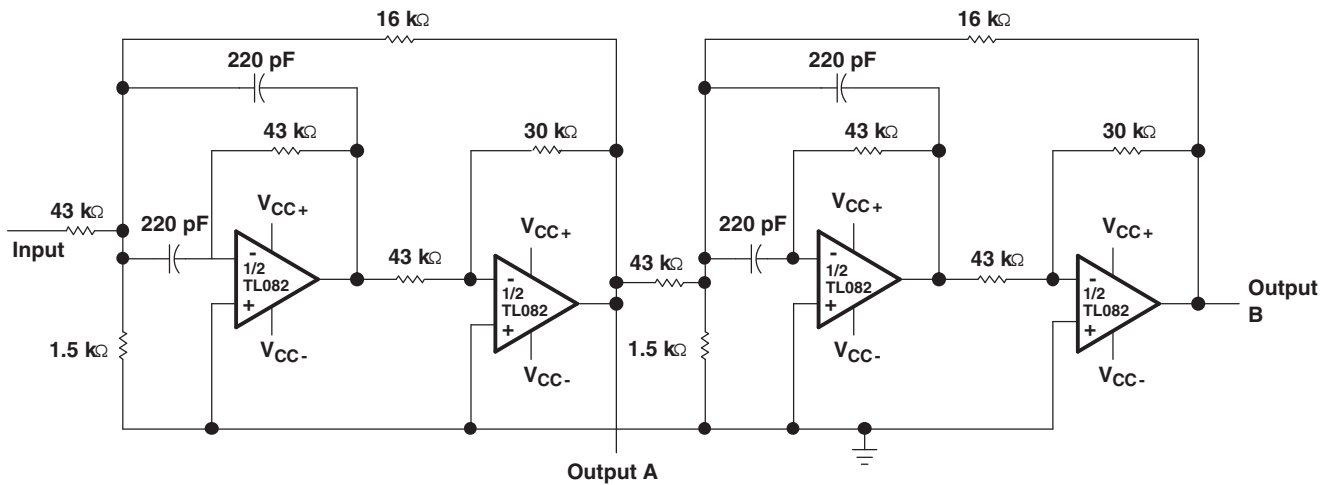


Figure 22. Audio-Distribution Amplifier

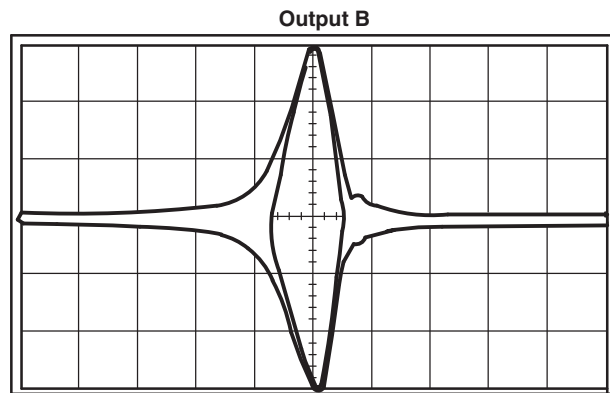


A. These resistor values may be adjusted for a symmetrical output.

**Figure 23. 100-kHz Quadrature Oscillator**



2 kHz/div  
 Second-Order Bandpass Filter  
 $f_0 = 100$  kHz,  $Q = 30$ , GAIN = 4



2 kHz/div  
 Cascaded Bandpass Filter  
 $f_0 = 100$  kHz,  $Q = 69$ , GAIN = 16

**Figure 24. Positive-Feedback Bandpass Filter**

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TL082IDRQ1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL082QDRQ1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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**OTHER QUALIFIED VERSIONS OF TL082-Q1 :**

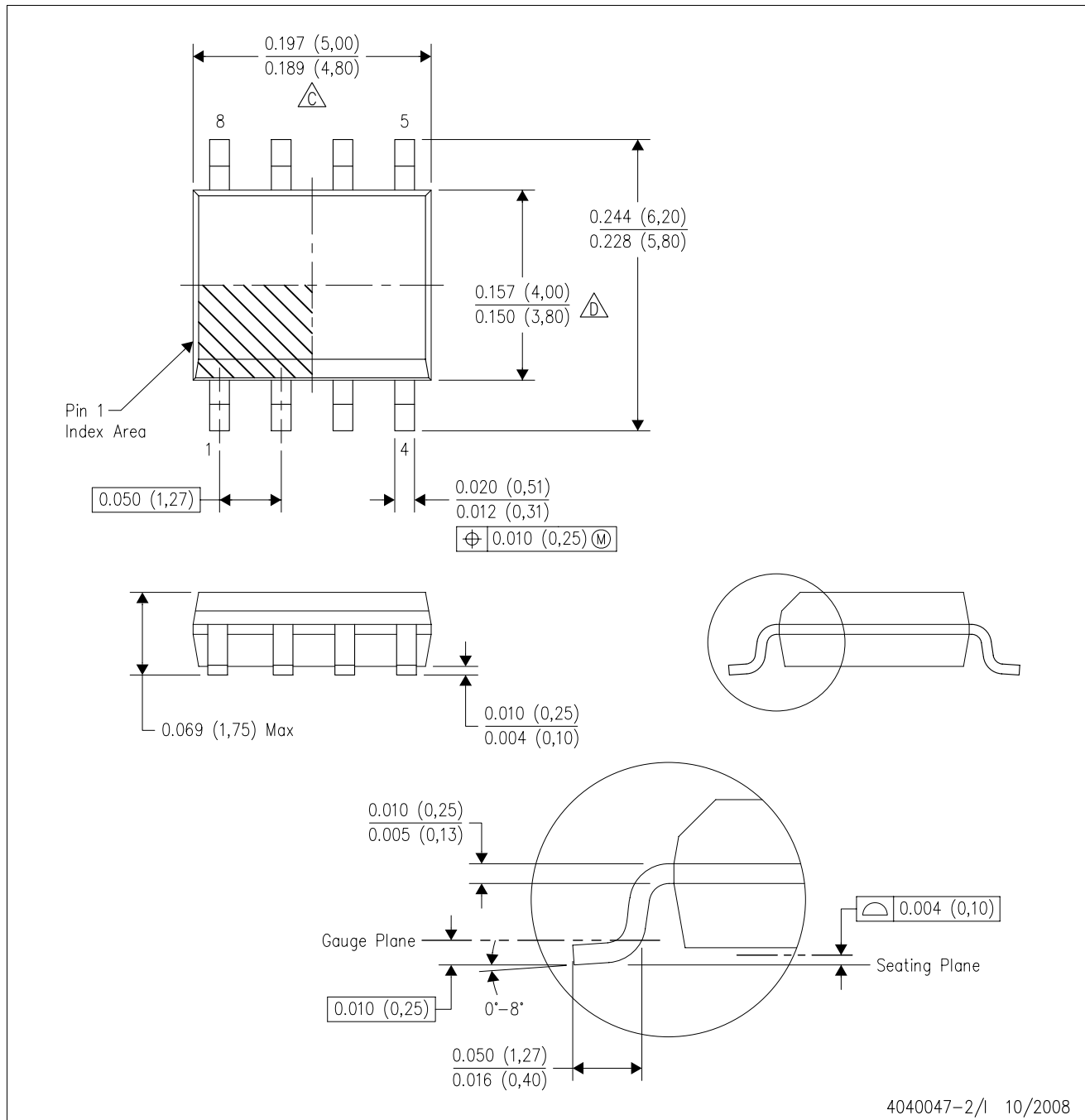
- Catalog: [TL082](#)
- Military: [TL082M](#)

NOTE: Qualified Version Definitions:

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

D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (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 .006 (0,15) per end.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
  - E. Reference JEDEC MS-012 variation AA.

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DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
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RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>

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