TEXAS INSTRUMENTS

LM158, LM158A, LM258, LM258A
LM358, LM358A, LM358B, LM358BA, LM2904, LM2904B, LM2904BA, LM2904V

SLOS068X – JUNE 1976 – REVISED JUNE 2020

# Industry-Standard Dual Operational Amplifiers

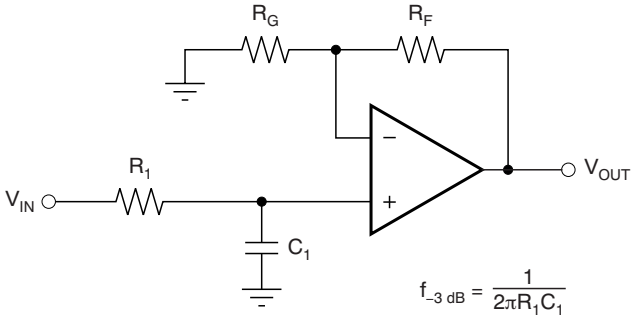
## 1 Features

- Wide supply range of 3 V to 36 V (B version)
- Quiescent current: 300 µA per amplifier (B version, typical)
- Unity-gain bandwidth of 1.2 MHz (B version)
- Common-mode input voltage range includes ground, enabling direct sensing near ground
- Low input offset voltage of 3 mV at 25°C (A and B versions, maximum)
- Internal RF and EMI filter (B version)
- On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

## 2 Applications

- Merchant network and server power supply units
- Multi-function printers
- Power supplies and mobile chargers
- Motor control: AC induction, brushed DC, brushless DC, high-voltage, low-voltage, permanent magnet, and stepper motor
- Desktop PC and motherboard
- Indoor and outdoor air conditioners
- Washers, dryers, and refrigerators
- AC inverters, string inverters, central inverters, and voltage frequency drives
- Uninterruptible power supplies
- Programmable logic controllers
- Electronic point-of-sale systems

**Single-Pole, Low-Pass Filter**




$$\frac{V_{OUT}}{V_{IN}} = \left(1 + \frac{R_F}{R_G}\right)\left(\frac{1}{1 + sR_1C_1}\right)$$

## 3 Description

The LM358B and LM2904B devices are the next-generation versions of the industry-standard operational amplifiers (op amps) LM358 and LM2904, which include two high-voltage (36-V) op amps. These devices provide outstanding value for cost-sensitive applications, with features including low offset (300 µV, typical), common-mode input range to ground, and high differential input voltage capability.

The LM358B and LM2904B op amps simplify circuit design with enhanced features such as unity-gain stability, lower offset voltage of 3 mV (maximum at room temperature), and lower quiescent current of 300 µA per amplifier (typical). High ESD (2 kV, HBM) and integrated EMI and RF filters enable the LM358B and LM2904B devices to be used in the most rugged, environmentally challenging applications.

The LM358B and LM2904B amplifiers are available in micro-sized packaging, such as the SOT23-8, as well as industry standard packages, including SOIC, TSSOP, and VSSOP.

**Device Information(1)**

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|---|---|---|
| LM358B, LM2904B, LM358, LM358A, LM2904, LM2904V, LM258, LM258A | SOIC (8) | 4.90 mm × 3.90 mm |
| LM358B, LM2904B, LM358, LM358A, LM2904, LM2490V | TSSOP (8) | 3.00 mm × 4.40 mm |
| LM358B(2), LM2904B(2), LM358, LM358A, LM2904, LM2904V, LM258, LM258A | VSSOP (8) | 3.00 mm × 3.00 mm |
| LM358B(2), LM2904B(2) | SOT-23 (8) | 2.90 mm × 1.60 mm |
| LM358, LM2904 | SO (8) | 5.20 mm × 5.30 mm |
| LM358, LM2904, LM358A, LM258, LM258A | PDIP (8) | 9.81 mm × 6.35 mm |
| LM158, LM158A | CDIP (8) | 9.60 mm × 6.67 mm |
| LM158, LM158A | LCCC (20) | 8.89 mm × 8.89 mm |

(1) For all available packages, see the orderable addendum at the end of the data sheet.

(2) Package is for preview only.

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## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

**Changes from Revision W (October 2019) to Revision X** **Page**

- Added application links to *Applications* section ... 1
- Deleted preview tag from LM358B and LM2904B TSSOP (8) package in *Device Information* table ... 1
- Changed section title from *Community Resources* to *Support Resources* ... 29

**Changes from Revision V (September 2018) to Revision W** **Page**

- Added specification in the *Device Comparison Table* ... 4
- Changed CDM ESD rating for LM358B and LM2904B in *ESD Ratings* ... 6
- Changed $V_S$ to V+ in *Recommended Operating Conditions* ... 7
- Changed *Thermal Information* for the LM158FK and LM158JG devices ... 7
- Added *Typical Characteristics* section for the LM358B and LM2490B op amps ... 14
- Added test circuit for THD+N and small-signal step response, G = –1 in the *Parameter Measurement Information* section ... 23
- Changed the Functional Block Diagram ... 24
- Deleted preview designator from LM358B and LM2904B in the *Related Links* section ... 29

**Changes from Revision U (January 2017) to Revision V** **Page**

- Changed the data sheet title ... 1
- Changed first four items in the *Features* section ... 1
- Changed the first item in the Applications section and added four new items ... 1
- Changed voltage values in the first paragraph of the *Description* section ... 1

- Changed text in the second paragraph of the *Description* section ... 1
- Added devices LM358B and LM2904B to data sheet ... 1
- Changed the first three rows of the *Device Information* table and added a a cross-referenced note for PREVIEW-status devices ... 1
- Added *Device Comparison* table ... 4
- Added a table note to the *Pin Functions* table ... 5
- Changed "free-air temperature" to "ambient temperature" in the *Absolute Maximum Ratings* condition statement ... 6
- Changed all entries in the *Absolute Maximum Ratings* table except $T_J$ and $T_{stg}$ ... 6
- Deleted lead temperature and case temperature from *Absolute Maximum Ratings* ... 6
- Changed device listings and their voltage values in the *ESD Ratings* table ... 6
- Changed "free-air temperature" to "ambient temperature" in the *Recommended Operating Conditions* condition statement ... 7
- Changed table entries for all parameters in the *Recommended Operating Conditions* table ... 7
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- Deleted the *Operating Conditions* table ... 13
- Added a condition statement to the *Typical Characteristics* section ... 21
- Changed specific voltages to a *Recommended Operating Conditions* reference ... 24
- Changed unity-gain bandwidth from 0.7 MHz for all devices to 1.2 MHz for B-version devices ... 25
- Changed slew rate from.3 V/µs for all devices to o.5 V/µs for B-version devices ... 25
- Changed the Input Common Mode Range section in multiple places throughout ... 25
- Changed $V_{CC}$ to $V_S$ in the *Application Information* section ... 26
- Subscripted the suffixes fro $R_I$ and $R_F$ ... 26
- Changed *Operational Amplifier Board Layout for Noninverting Configuration* with an image that includes a dual op amp 28
- Added Preview designation to the LM358B and LM2904B devices in Table 1 ... 29

**Changes from Revision T (April 2015) to Revision U** **Page**

- Changed data sheet title ... 1
- Added *Receiving Notification of Documentation Updates* section and *Community Resources* section ... 29

**Changes from Revision S (January 2014) to Revision T** **Page**

- Added *Applications* section, *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section ... 1

**Changes from Revision R (July 2010) to Revision S** **Page**

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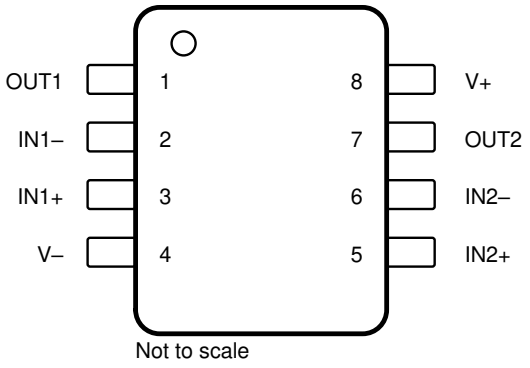
- Deleted *Ordering Information* table ... 1
- Updated *Features* to include Military Disclaimer ... 1
- Added Typical Characteristics section ... 21
- Added ESD warning ... 29

# 5 Device Comparison Table

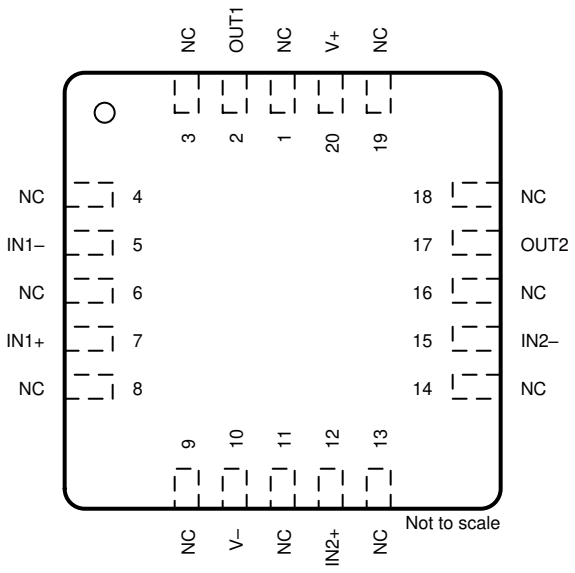
| PART NUMBER | SUPPLY VOLTAGE | TEMPERATURE RANGE | $V_{OS}$ (MAXIMUM AT 25°C) | $I_Q$ / CH (TYPICAL AT 25°C) | INTEGRATED EMI FILTER | PACKAGE |
|---|---|---|---|---|---|---|
| LM358B | 3 V–36 V | –40°C to 85°C | 3 mV | 300 µA | Yes | D, DDF, DGK, PW |
| LM2904B | 3 V–36 V | –40°C to 125°C | 3 mV | 300 µA | Yes | D, DDF, DGK, PW |
| LM358 | 3 V–32 V | 0°C to 70°C | 7 mV | 350 µA | No | D, PW, DGK, P, PS |
| LM2904 | 3 V–26 V | –40°C to 125°C | 7 mV | 350 µA | No | D, PW, DGK, P, PS |
| LM358A | 3 V–32 V | 0°C to 70°C | 3 mV | 350 µA | No | D, PW, DGK, P |
| LM2904V | 3 V–32 V | –40°C to 125°C | 7 mV | 350 µA | No | D, PW |
| LM158 | 3 V–32 V | –55°C to 125°C | 5 mV | 350 µA | No | JG, FK |
| LM158A | 3 V–32 V | –55°C to 125°C | 3 mV | 350 µA | No | JG, FK |
| LM258 | 3 V–32 V | –25°C to 85°C | 5 mV | 350 µA | No | D, DGK, P |
| LM258A | 3 V–32 V | –25°C to 85°C | 3 mV | 350 µA | No | D, DGK, P |

# 6 Pin Configuration and Functions

**D, DDF, DGK, P, PS, PW, and JG Packages**
**8-Pin SOIC, SOT23-8, VSSOP, PDIP, SO, TSSOP, and CDIP**
**Top View**




**FK Package**
**20-Pin LCCC**
**Top View**




NC - No internal connection

**Pin Functions**

| PIN | | | I/O | DESCRIPTION |
|---|---|---|---|---|
| NAME | LCCC[1] | SOIC, SOT23-8, VSSOP, CDIP, PDIP, SO, TSSOP, CFP[1] | | |
| IN1– | 5 | 2 | I | Negative input |
| IN1+ | 7 | 3 | I | Positive input |
| IN2– | 15 | 6 | I | Negative input |
| IN2+ | 12 | 5 | I | Positive input |
| OUT1 | 2 | 1 | O | Output |
| OUT2 | 17 | 7 | O | Output |
| V– | 10 | 4 | — | Negative (lowest) supply or ground (for single-supply operation) |
| NC | 1, 3, 4, 6, 8, 9, 11, 13, 14, 16, 18, 19 | — | — | No internal connection |
| V+ | 20 | 8 | — | Positive (highest) supply |

(1) For a listing of which devices are available in what packages, see *Device Comparison Table*.

# 7 Specifications

## 7.1 Absolute Maximum Ratings

over operating ambient temperature range (unless otherwise noted)(1)

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| Supply voltage, $V_S$ = ([V+] – [V–]) | | LM358B, LM358BA, LM2904B, LM2904BA | | ±20 or 40 | V |
| | | LM158, LM258, LM358, LM158A, LM258A, LM358A, LM2904V | | ±16 or 32 | |
| | | LM2904 | | ±13 or 26 | |
| Differential input voltage, $V_{ID}$(2) | | LM358B, LM358BA, LM2904B, LM2904BA,LM158, LM258, LM358, LM158A, LM258A, LM358A, LM2904V | –32 | 32 | V |
| | | LM2904 | –26 | 26 | |
| Input voltage, $V_I$ | Either input | LM358B, LM358BA, LM2904B, LM2904BA | –0.3 | 40 | V |
| | | LM158, LM258, LM358, LM158A, LM258A, LM358A, LM2904V | –0.3 | 32 | |
| | | LM2904 | –0.3 | 26 | |
| Duration of output short circuit (one amplifier) to ground at (or below) $T_A$ = 25°C, $V_S$ ≤ 15 V(3) | | | | Unlimited | s |
| Operating ambient temperature, $T_A$ | | LM158, LM158A | –55 | 125 | °C |
| | | LM258, LM258A | –25 | 85 | |
| | | LM358B, LM358BA | –40 | 85 | |
| | | LM358, LM358A | 0 | 70 | |
| | | LM2904B, LM2904BA, LM2904, LM2904V | –40 | 125 | |
| Operating virtual-junction temperature, $T_J$ | | | | 150 | °C |
| Storage temperature, $T_{stg}$ | | | –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 do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) Differential voltages are at IN+, with respect to IN−.
(3) Short circuits from outputs to $V_S$ can cause excessive heating and eventual destruction.

## 7.2 ESD Ratings

| | | | VALUE | UNIT |
|---|---|---|---|---|
| **LM358B, LM358BA, LM2904B, AND LM2904BA** | | | | |
| $V_{(ESD)}$ | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1) | ±2000 | V |
| | | Charged-device model (CDM), per JEDEC specification JESD22-C101(2) | ±1000 | |
| **LM158, LM258, LM358, LM158, LM258A, LM358A, LM2904, AND LM2904V** | | | | |
| $V_{(ESD)}$ | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1) | ±500 | V |
| | | Charged-device model (CDM), per JEDEC specification JESD22-C101(2) | ±1000 | |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

## 7.3 Recommended Operating Conditions

over operating ambient temperature range (unless otherwise noted)

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_S$ | Supply voltage, $V_S$= ([V+] – [V–]) | LM358B, LM358BA, LM2904B, LM2904BA | 3 | 36 | V |
| | | LM158, LM258, LM358, LM158A, LM258A, LM358A, LM2904V | 3 | 30 | |
| | | LM2904 | 3 | 26 | |
| $V_{CM}$ | Common-mode voltage | | V– | V+ – 2 | V |
| $T_A$ | Operating ambient temperature | LM358B, LM358BA | –40 | 85 | °C |
| | | LM2904B, LM2904BA, LM2904, LM2904V | –40 | 125 | |
| | | LM358, LM358A | 0 | 70 | |
| | | LM258, LM258A | –20 | 85 | |
| | | LM158, LM158A | –55 | 125 | |

## 7.4 Thermal Information

| THERMAL METRIC[1] | | LM258, LM258A, LM358, LM358A, LM358B, LM358BA, LM2904, LM2904B, LM2904BA, LM2904V[2] | | | | | LM158, LM158A | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | D (SOIC) | DGK (VSSOP) | P (PDIP) | PS (SO) | PW (TSSOP) | FK (LCCC) | JG (CDIP) | |
| | | 8 PINS | 8 PINS | 8 PINS | 8 PINS | 8 PINS | 20 PINS | 8 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 124.7 | 181.4 | 80.9 | 116.9 | 171.7 | 84.0 | 112.4 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 66.9 | 69.4 | 70.4 | 62.5 | 68.8 | 56.9 | 63.6 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 67.9 | 102.9 | 57.4 | 68.6 | 99.2 | 57.5 | 100.3 | °C/W |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 19.2 | 11.8 | 40 | 21.9 | 11.5 | 51.7 | 35.7 | °C/W |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 67.2 | 101.2 | 56.9 | 67.6 | 97.9 | 57.1 | 93.3 | °C/W |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | — | — | — | — | — | 10.6 | 22.3 | °C/W |

(1) For more information about traditional and new thermal metrics, see *Semiconductor and IC Package Thermal Metrics*.
(2) For a listing of which devices are available in what packages, see *Device Comparison Table*.

## 7.5 Electrical Characteristics: LM358B and LM358BA

$V_S$ = (V+) – (V–) = 5 V - 36 V (±2.5 V - ±18 V), $T_A$ = 25°C, $V_{CM}$ = $V_{OUT}$ = $V_S$/2, $R_L$ = 10k connected to $V_S$/2 (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| **OFFSET VOLTAGE** | | | | | | | | |
| $V_{OS}$ | Input offset voltage | LM358B | | | | ±0.3 | ±3.0 | mV |
| | | | | $T_A$ = –40°C to +85°C | | | ±4 | mV |
| | | LM358BA | | | | | ±2.0 | mV |
| | | | | $T_A$ = –40°C to +85°C | | | ±2.5 | mV |
| $dV_{OS}/d_T$ | Input offset voltage drift | | | $T_A$ = -40°C to +85°C(1) | | ±3.5 | 11 | µV/°C |
| PSRR | Power Supply Rejection Ratio | | | | | ±2 | 15 | µV/V |
| | Channel separation, dc | f = 1 kHz to 20 kHz | | | | ±1 | | µV/V |
| **INPUT VOLTAGE RANGE** | | | | | | | | |
| $V_{CM}$ | Common-mode voltage range | $V_S$ = 3 V to 36 V | | | (V–) | | (V+) – 1.5 | V |
| | | $V_S$ = 5 V to 36 V | | $T_A$ = –40°C to +85°C | (V–) | | (V+) – 2 | V |
| CMRR | Common-mode rejection ratio | (V–) ≤ $V_{CM}$ ≤ (V+) – 1.5 V | $V_S$ = 3 V to 36 V | | | 20 | 100 | µV/V |
| | | (V–) ≤ $V_{CM}$ ≤ (V+) – 2.0 V | $V_S$ = 5 V to 36 V | $T_A$ = –40°C to +85°C | | 25 | 316 | µV/V |
| **INPUT BIAS CURRENT** | | | | | | | | |
| $I_B$ | Input bias current | | | | | ±10 | ±35 | nA |
| | | | | $T_A$ = –40°C to +85°C(1) | | | ±50 | nA |
| $I_{OS}$ | Input offset current | | | | | 0.5 | 4 | nA |
| | | | | $T_A$ = –40°C to +85°C(1) | | | 5 | nA |
| $dI_{OS}/d_T$ | Input offset current drift | | | $T_A$ = –40°C to +85°C | | 10 | | pA/°C |
| **NOISE** | | | | | | | | |
| $E_n$ | Input voltage noise | f = 0.1 to 10 Hz | | | | 3 | | $µV_{PP}$ |
| $e_n$ | Input voltage noise density | f = 1 kHz | | | | 40 | | nV/√Hz |
| **INPUT IMPEDANCE** | | | | | | | | |
| $Z_{ID}$ | Differential | | | | | 10 \|\| 0.1 | | MΩ\|\| pF |
| $Z_{IC}$ | Common-mode | | | | | 4 \|\| 1.5 | | GΩ\|\| pF |
| **OPEN-LOOP GAIN** | | | | | | | | |
| $A_{OL}$ | Open-loop voltage gain | $V_S$ = 15 V; $V_O$ = 1 V to 11 V; $R_L$ ≥ 10 kΩ, connected to (V-) | | | 70 | 140 | | V/mV |
| | | | | $T_A$ = –40°C to +85°C | 35 | | | V/mV |
| **FREQUENCY RESPONSE** | | | | | | | | |
| GBW | Gain bandwidth product | | | | | 1.2 | | MHz |
| SR | Slew rate | G = + 1 | | | | 0.5 | | V/µs |
| $Θ_m$ | Phase margin | G = + 1, $R_L$ = 10kΩ, $C_L$ = 20 pF | | | | 56 | | ° |
| $t_{OR}$ | Overload recovery time | $V_{IN}$ × gain > $V_S$ | | | | 10 | | µs |
| $t_s$ | Settling time | To 0.1%, $V_S$ = 5 V, 2-V Step , G = +1, $C_L$ = 100 pF | | | | 4 | | µs |
| THD+N | Total harmonic distortion + noise | G = + 1, f = 1 kHz, $V_O$ = 3.53 $V_{RMS}$, $V_S$ = 36V, $R_L$ = 100k, $I_{OUT}$ ≤ ±50µA, BW = 80 kHz | | | | 0.001 | | % |
| **OUTPUT** | | | | | | | | |
| $V_O$ | Voltage output swing from rail | Positive Rail (V+) | | $I_{OUT}$ = 50 µA | | 1.35 | 1.42 | V |
| | | | | $I_{OUT}$ = 1 mA | | 1.4 | 1.48 | V |
| | | | | $I_{OUT}$ = 5 mA(1) | | 1.5 | 1.61 | V |
| | | Negative Rail (V-) | | $I_{OUT}$ = 50 µA | | 100 | 150 | mV |
| | | | | $I_{OUT}$ = 1 mA | | 0.75 | 1 | V |
| | | | $V_S$ = 5 V, RL ≤ 10 kΩ connected to (V–) | $T_A$ = –40°C to +85°C | | 5 | 20 | mV |
| $I_O$ | Output current | $V_S$ = 15 V; $V_O$ = V-; $V_{ID}$ = 1 V | Source(1) | | -20 | -30 | | mA |
| | | | | $T_A$ = –40°C to +85°C | -10 | | | |
| | | $V_S$ = 15 V; $V_O$ = V+; $V_{ID}$ = -1 V | Sink(1) | | 10 | 20 | | |
| | | | | $T_A$ = –40°C to +85°C | 5 | | | |
| | | $V_{ID}$ = -1 V; $V_O$ = (V-) + 200 mV | | | 60 | 100 | | µA |
| $I_{SC}$ | Short-circuit current | $V_S$ = 20 V, (V+) = 10 V, (V-) = -10 V, $V_O$ = 0 V | | | | ±40 | ±60 | mA |
| $C_{LOAD}$ | Capacitive load drive | | | | | 100 | | pF |
| $R_O$ | Open-loop output resistance | f = 1 MHz, $I_O$ = 0 A | | | | 300 | | Ω |
| **POWER SUPPLY** | | | | | | | | |
| $I_Q$ | Quiescent current per amplifier | $V_S$ = 5 V; $I_O$ = 0 A | | $T_A$ = –40°C to +85°C | | 300 | 460 | µA |
| $I_Q$ | Quiescent current per amplifier | $V_S$ = 36 V; $I_O$ = 0 A | | | | | 800 | µA |

(1) Specified by characterization only

## 7.6 Electrical Characteristics: LM2904B and LM2904BA

$V_S$ = (V+) – (V–) = 5 V - 36 V (±2.5 V - ±18 V), $T_A$ = 25°C, $V_{CM}$ = $V_{OUT}$ = $V_S$/2, $R_L$ = 10k connected to $V_S$/2 (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| **OFFSET VOLTAGE** | | | | | | | | |
| $V_{OS}$ | Input offset voltage | LM2904B | | | | ±0.3 | ±3.0 | mV |
| | | | | $T_A$ = –40°C to +125°C | | | ±4 | mV |
| | | LM2904BA | | | | | ±2.0 | mV |
| | | | | $T_A$ = –40°C to +125°C | | | ±2.5 | mV |
| $dV_{OS}/d_T$ | Input offset voltage drift | | | $T_A$ = –40°C to +125°C(1) | | ±3.5 | 12 | µV/°C |
| PSRR | Power Supply Rejection Ratio | | | | | ±2 | 15 | µV/V |
| | Channel separation, dc | f = 1 kHz to 20 kHz | | | | ±1 | | µV/V |
| **INPUT VOLTAGE RANGE** | | | | | | | | |
| $V_{CM}$ | Common-mode voltage range | $V_S$ = 3 V to 36 V | | | (V–) | | (V+) – 1.5 | V |
| | | $V_S$ = 5 V to 36 V | | $T_A$ = –40°C to +125°C | (V–) | | (V+) – 2 | V |
| CMRR | Common-mode rejection ratio | (V–) ≤ $V_{CM}$ ≤ (V+) – 1.5 V | $V_S$ = 3 V to 36 V | | | 20 | 100 | µV/V |
| | | (V–) ≤ $V_{CM}$ ≤ (V+) – 2.0 V | $V_S$ = 5 V to 36 V | $T_A$ = –40°C to +125°C | | 25 | 316 | |
| **INPUT BIAS CURRENT** | | | | | | | | |
| $I_B$ | Input bias current | | | | | ±10 | ±35 | nA |
| | | | | $T_A$ = –40°C to +125°C(1) | | | ±50 | nA |
| $I_{OS}$ | Input offset current | | | | | 0.5 | 4 | nA |
| | | | | $T_A$ = –40°C to +125°C(1) | | | 5 | nA |
| $dI_{OS}/d_T$ | Input offset current drift | | | $T_A$ = –40°C to +125°C | | 10 | | pA/°C |
| **NOISE** | | | | | | | | |
| $E_n$ | Input voltage noise | f = 0.1 to 10 Hz | | | | 3 | | $µV_{PP}$ |
| $e_n$ | Input voltage noise density | f = 1 kHz | | | | 40 | | nV/√Hz |
| **INPUT IMPEDANCE** | | | | | | | | |
| $Z_{ID}$ | Differential | | | | | 10 \|\| 0.1 | | MΩ\|\| pF |
| $Z_{IC}$ | Common-mode | | | | | 4 \|\| 1.5 | | GΩ\|\| pF |
| **OPEN-LOOP GAIN** | | | | | | | | |
| $A_{OL}$ | Open-loop voltage gain | $V_S$ = 15 V; $V_O$ = 1 V to 11 V; $R_L$ ≥ 10 kΩ, connected to (V-) | | | 70 | 140 | | V/mV |
| | | | | $T_A$ = –40°C to +125°C | 35 | | | V/mV |
| **FREQUENCY RESPONSE** | | | | | | | | |
| GBW | Gain bandwidth product | | | | | 1.2 | | MHz |
| SR | Slew rate | G = + 1 | | | | 0.5 | | V/µs |
| $Θ_m$ | Phase margin | G = + 1, $R_L$ = 10kΩ, $C_L$ = 20 pF | | | | 56 | | ° |
| $t_{OR}$ | Overload recovery time | $V_{IN}$ × gain > $V_S$ | | | | 10 | | µs |
| $t_s$ | Settling time | To 0.1%, $V_S$ = 5 V, 2-V Step , G = +1, $C_L$ = 100 pF | | | | 4 | | µs |
| THD+N | Total harmonic distortion + noise | G = + 1, f = 1 kHz, $V_O$ = 3.53 $V_{RMS}$, $V_S$ = 36V, $R_L$ = 100k, $I_{OUT}$ ≤ ±50µA, BW = 80 kHz | | | | 0.001 | | % |
| **OUTPUT** | | | | | | | | |
| $V_O$ | Voltage output swing from rail | Positive Rail (V+) | | $I_{OUT}$ = 50 µA | | 1.35 | 1.42 | V |
| | | | | $I_{OUT}$ = 1 mA | | 1.4 | 1.48 | V |
| | | | | $I_{OUT}$ = 5 mA(1) | | 1.5 | 1.61 | V |
| | | Negative Rail (V-) | | $I_{OUT}$ = 50 µA | | 100 | 150 | mV |
| | | | | $I_{OUT}$ = 1 mA | | 0.75 | 1 | V |
| | | | $V_S$ = 5 V, RL ≤ 10 kΩ connected to (V–) | $T_A$ = –40°C to +125°C | | 5 | 20 | mV |
| $I_O$ | Output current | $V_S$ = 15 V; $V_O$ = V-; $V_{ID}$ = 1 V | Source(1) | | -20 | -30 | | mA |
| | | | | $T_A$ = –40°C to +125°C | -10 | | | |
| | | $V_S$ = 15 V; $V_O$ = V+; $V_{ID}$ = -1 V | Sink(1) | | 10 | 20 | | |
| | | | | $T_A$ = –40°C to +125°C | 5 | | | |
| | | $V_{ID}$ = -1 V; $V_O$ = (V-) + 200 mV | | | 60 | 100 | | µA |
| $I_{SC}$ | Short-circuit current | $V_S$ = 20 V, (V+) = 10 V, (V-) = -10 V, $V_O$ = 0 V | | | | ±40 | ±60 | mA |
| $C_{LOAD}$ | Capacitive load drive | | | | | 100 | | pF |
| $R_O$ | Open-loop output resistance | f = 1 MHz, $I_O$ = 0 A | | | | 300 | | Ω |
| **POWER SUPPLY** | | | | | | | | |
| $I_Q$ | Quiescent current per amplifier | $V_S$ = 5 V; $I_O$ = 0 A | | $T_A$ = –40°C to +125°C | | 300 | 460 | µA |
| $I_Q$ | Quiescent current per amplifier | $V_S$ = 36 V; $I_O$ = 0 A | | | | | 800 | µA |

(1) Specified by characterization only

## 7.7 Electrical Characteristics: LM358, LM358A

For $V_S$ = (V+) – (V–) = 5 V, $T_A$ = 25 °C, (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS[1] | | | MIN | TYP[2] | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| **OFFSET VOLTAGE** | | | | | | | | |
| $V_{OS}$ | Input offset voltage | $V_S$ = 5 V to 30 V; $V_{CM}$ = 0 V; $V_O$ = 1.4 V | LM358 | | | 3 | 7 | mV |
| | | | | $T_A$ = 0°C to 70°C | | | 9 | |
| | | | LM358A | | | 2 | 3 | |
| | | | | $T_A$ = 0°C to 70°C | | | 5 | |
| $dV_{OS}/d_T$ | Input offset voltage drift | | LM358 | $T_A$ = 0°C to 70°C | | 7 | | µV/°C |
| | | | LM358A | $T_A$ = 0°C to 70°C | | 7 | 20 | |
| PSRR | Input offset voltage vs power supply ($\Delta V_{IO}/\Delta V_S$) | $V_S$ = 5 V to 30 V | | | 65 | 100 | | dB |
| $V_{O1}/V_{O2}$ | Channel separation | f = 1 kHz to 20 kHz | | | | 120 | | dB |
| **INPUT VOLTAGE RANGE** | | | | | | | | |
| $V_{CM}$ | Common-mode voltage range | $V_S$ = 5 V to 30 V | LM358 | | (V–) | | (V+) – 1.5 | V |
| | | $V_S$ = 30 V | LM358A | | | | | |
| | | $V_S$ = 5 V to 30 V | LM358 | $T_A$ = 0°C to 70°C | (V–) | | (V+) – 2 | |
| | | $V_S$ = 30 V | LM358A | | | | | |
| CMRR | Common-mode rejection ratio | $V_S$ = 5 V to 30 V; $V_{CM}$ = 0 V | | | 65 | 80 | | dB |
| **INPUT BIAS CURRENT** | | | | | | | | |
| $I_B$ | Input bias current | $V_O$ = 1.4 V | LM358 | | | –20 | –250 | nA |
| | | | | $T_A$ = 0°C to 70°C | | | –500 | |
| | | | LM358A | | | –15 | –100 | |
| | | | | $T_A$ = 0°C to 70°C | | | –200 | |
| $I_{OS}$ | Input offset current | $V_O$ = 1.4 V | LM358 | | | 2 | 50 | nA |
| | | | | $T_A$ = 0°C to 70°C | | | 150 | |
| | | | LM358A | | | 2 | 30 | |
| | | | | $T_A$ = 0°C to 70°C | | | 75 | |
| $dI_{OS}/d_T$ | Input offset current drift | | | | | 10 | | pA/°C |
| | | | LM358A | $T_A$ = 0°C to 70°C | | | 300 | |
| **NOISE** | | | | | | | | |
| $e_n$ | Input voltage noise density | f = 1 kHz | | | | 40 | | nV/√Hz |
| **OPEN-LOOP GAIN** | | | | | | | | |
| $A_{OL}$ | Open-loop voltage gain | $V_S$ = 15 V; $V_O$ = 1 V to 11 V; $R_L$ ≥ 2 kΩ | | | 25 | 100 | | V/mV |
| | | | | $T_A$ = 0°C to 70°C | 15 | | | |
| **FREQUENCY RESPONSE** | | | | | | | | |
| GBW | Gain bandwidth product | | | | | 0.7 | | MHz |
| SR | Slew rate | G = +1 | | | | 0.3 | | V/µs |
| **OUTPUT** | | | | | | | | |
| $V_O$ | Voltage output swing from rail | Positive rail | $V_S$ = 30 V; $R_L$ = 2 kΩ | $T_A$ = 0°C to 70°C | | | 4 | V |
| | | | $V_S$ = 30 V; $R_L$ ≥ 10 kΩ | | | 2 | 3 | |
| | | | $V_S$ = 5 V; $R_L$ ≥ 2 kΩ | | | | 1.5 | |
| | | Negative rail | $V_S$ = 5 V; $R_L$ ≤ 10 kΩ | $T_A$ = 0°C to 70°C | | 5 | 20 | mV |
| $I_O$ | Output current | $V_S$ = 15 V; $V_O$ = 0 V; $V_{ID}$ = 1 V | Source | | –20 | –30 | | mA |
| | | | | LM358A | | | –60 | |
| | | | | $T_A$ = 0°C to 70°C | –10 | | | |
| | | $V_S$ = 15 V; $V_O$ = 15 V; $V_{ID}$ = –1 V | Sink | | 10 | 20 | | |
| | | | | $T_A$ = 0°C to 70°C | 5 | | | |
| | | $V_{ID}$ = –1 V; $V_O$ = 200 mV | | | 12 | 30 | | µA |
| $I_{SC}$ | Short-circuit current | $V_S$ = 10 V; $V_O$ = $V_S$ / 2 | | | | ±40 | ±60 | mA |
| **POWER SUPPLY** | | | | | | | | |
| $I_Q$ | Quiescent current per amplifier | $V_O$ = 2.5 V; $I_O$ = 0 A | | $T_A$ = 0°C to 70°C | | 350 | 600 | µA |
| | | $V_S$ = 30 V; $V_O$ = 15 V; $I_O$ = 0 A | | | | 500 | 1000 | |

(1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. Maximum $V_S$ for testing purposes is 30 V for LM358 and LM358A.
(2) All typical values are $T_A$ = 25°C.

## 7.8 Electrical Characteristics: LM2904, LM2904V

For $V_S$ = (V+) – (V–) = 5 V, $T_A$ = 25 °C, (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS[1] | | | | MIN | TYP [2] | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| **OFFSET VOLTAGE** | | | | | | | | | |
| $V_{OS}$ | Input offset voltage | $V_S$ = 5 V to maximum; $V_{CM}$ = 0 V; $V_O$ = 1.4 V | Non-A suffix devices | | | | 3 | 7 | mV |
| | | | | | $T_A$ = –40°C to 125°C | | | 10 | |
| | | | A-suffix devices | | | | 1 | 2 | |
| | | | | | $T_A$ = –40°C to 125°C | | | 4 | |
| $dV_{OS}/d_T$ | Input offset voltage drift | | | | $T_A$ = –40°C to 125°C | | 7 | | µV/°C |
| PSRR | Input offset voltage vs power supply ($\Delta V_{IO}/\Delta V_S$) | $V_S$ = 5 V to 30 V | | | | 65 | 100 | | dB |
| $V_{O1}/V_{O2}$ | Channel separation | f = 1 kHz to 20 kHz | | | | | 120 | | dB |
| **INPUT VOLTAGE RANGE** | | | | | | | | | |
| $V_{CM}$ | Common-mode voltage range | $V_S$ = 5 V to maximum | | | | (V–) | | (V+) – 1.5 | V |
| | | | | | $T_A$ = –40°C to 125°C | (V–) | | (V+) – 2 | |
| CMRR | Common-mode rejection ratio | $V_S$ = 5 V to maximum; $V_{CM}$ = 0 V | | | | 65 | 80 | | dB |
| **INPUT BIAS CURRENT** | | | | | | | | | |
| $I_B$ | Input bias current | $V_O$ = 1.4 V | | | | | –20 | –250 | nA |
| | | | | | $T_A$ = –40°C to 125°C | | | –500 | |
| $I_{OS}$ | Input offset current | $V_O$ = 1.4 V | Non-V suffix device | | | | 2 | 50 | nA |
| | | | | | $T_A$ = –40°C to 125°C | | | 300 | |
| | | | V-suffix device | | | | 2 | 50 | |
| | | | | | $T_A$ = –40°C to 125°C | | | 150 | |
| $dI_{OS}/d_T$ | Input offset current drift | | | | $T_A$ = –40°C to 125°C | | 10 | | pA/°C |
| **NOISE** | | | | | | | | | |
| $e_n$ | Input voltage noise density | f = 1 kHz | | | | | 40 | | nV/√Hz |
| **OPEN-LOOP GAIN** | | | | | | | | | |
| $A_{OL}$ | Open-loop voltage gain | $V_S$ = 15 V; $V_O$ = 1 V to 11 V; $R_L$ ≥ 2 kΩ | | | | 25 | 100 | | V/mV |
| | | | | | $T_A$ = –40°C to 125°C | 15 | | | |
| **FREQUENCY RESPONSE** | | | | | | | | | |
| GBW | Gain bandwidth product | | | | | | 0.7 | | MHz |
| SR | Slew rate | G = +1 | | | | | 0.3 | | V/µs |
| **OUTPUT** | | | | | | | | | |
| $V_O$ | Voltage output swing from rail | Positive rail | $R_L$ ≥ 10 kΩ | | | $V_S$ – 1.5 | | | V |
| | | | Non-V suffix device | $V_S$ = maximum; $R_L$ = 2 kΩ | $T_A$ = –40°C to 125°C | | | 4 | |
| | | | | $V_S$ = maximum; $R_L$ ≥ 10 kΩ | | | 2 | 3 | |
| | | | V-suffix device | $V_S$ = maximum; $R_L$ = 2 kΩ | | | | 6 | |
| | | | | $V_S$ = maximum; $R_L$ ≥ 10 kΩ | | | 4 | 5 | |
| | | Negative rail | | $V_S$ = 5 V; $R_L$ ≤ 10 kΩ | $T_A$ = –40°C to 125°C | | 5 | 20 | mV |
| $I_O$ | Output current | $V_S$ = 15 V; $V_O$ = 0 V; $V_{ID}$ = 1 V | | Source | | –20 | –30 | | mA |
| | | | | | $T_A$ = –40°C to 125°C | –10 | | | |
| | | $V_S$ = 15 V; $V_O$ = 15 V; $V_{ID}$ = –1 V | | Sink | | 10 | 20 | | |
| | | | | | $T_A$ = –40°C to 125°C | 5 | | | |
| | | $V_{ID}$ = -1 V; $V_O$ = 200 mV | | Non-V suffix device | | | 30 | | µA |
| | | | | V-suffix device | | 12 | 40 | | |
| $I_{SC}$ | Short-circuit current | $V_S$ = 10 V; $V_O$ = $V_S$ / 2 | | | | | ±40 | ±60 | mA |
| **POWER SUPPLY** | | | | | | | | | |
| $I_Q$ | Quiescent current per amplifier | $V_O$ = 2.5 V; $I_O$ = 0 A | | | $T_A$ = –40°C to 125°C | | 350 | 600 | µA |
| | | $V_S$ = maximum; $V_O$ = maximum / 2; $I_O$ = 0 A | | | | | 500 | 1000 | |

(1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. Maximum $V_S$ for testing purposes is 26 V for LM2904 and 32 V for LM2904V.
(2) All typical values are $T_A$ = 25°C.

## 7.9 Electrical Characteristics: LM158, LM158A

For $V_S$ = (V+) – (V–) = 5 V, $T_A$ = 25 °C, (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS[1] | | | | MIN | TYP[2] | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| **OFFSET VOLTAGE** | | | | | | | | | |
| $V_{OS}$ | Input offset voltage | $V_S$ = 5 V to 30 V; $V_{CM}$ = 0 V; $V_O$ = 1.4 V | | LM158 | | | 3 | 5 | mV |
| | | | | | $T_A$ = –55°C to 125°C | | | 7 | |
| | | | | LM158A | | | | 2 | |
| | | | | | $T_A$ = –55°C to 125°C | | | 4 | |
| $dV_{OS}/d_T$ | Input offset voltage drift | | | LM158 | $T_A$ = –55°C to 125°C | | 7 | | µV/°C |
| | | | | LM158A | $T_A$ = –55°C to 125°C | | 7 | 15[3] | |
| PSRR | Input offset voltage vs power supply ($\Delta V_{IO}/\Delta V_S$) | $V_S$ = 5 V to 30 V | | | | 65 | 100 | | dB |
| $V_{O1}$/ $V_{O2}$ | Channel separation | f = 1 kHz to 20 kHz | | | | | 120 | | dB |
| **INPUT VOLTAGE RANGE** | | | | | | | | | |
| $V_{CM}$ | Common-mode voltage range | $V_S$ = 5 V to 30 V | | LM158 | | (V–) | | (V+) – 1.5 | V |
| | | $V_S$ = 30 V | | LM158A | | | | | |
| | | $V_S$ = 5 V to 30 V | | LM158 | $T_A$ = –55°C to 125°C | (V–) | | (V+) – 2 | |
| | | $V_S$ = 30 V | | LM158A | | | | | |
| CMRR | Common-mode rejection ratio | $V_S$ = 5 V to 30 V; $V_{CM}$ = 0 V | | | | 70 | 80 | | dB |
| **INPUT BIAS CURRENT** | | | | | | | | | |
| $I_B$ | Input bias current | $V_O$ = 1.4 V | | LM158 | | | –20 | –150 | nA |
| | | | | | $T_A$ = –55°C to 125°C | | | –300 | |
| | | | | LM158A | | | –15 | –50 | |
| | | | | | $T_A$ = –55°C to 125°C | | | –100 | |
| $I_{OS}$ | Input offset current | $V_O$ = 1.4 V | | LM158 | | | 2 | 30 | nA |
| | | | | | $T_A$ = –55°C to 125°C | | | 100 | |
| | | | | LM158A | | | 2 | 10 | |
| | | | | | $T_A$ = –55°C to 125°C | | | 30 | |
| $dI_{OS}/d_T$ | Input offset current drift | | | | | | 10 | | pA/°C |
| | | | | LM158A | $T_A$ = –55°C to 125°C | | | 200 | |
| **NOISE** | | | | | | | | | |
| $e_n$ | Input voltage noise density | f = 1 kHz | | | | | 40 | | nV/√Hz |
| **OPEN-LOOP GAIN** | | | | | | | | | |
| $A_{OL}$ | Open-loop voltage gain | $V_S$ = 15 V; $V_O$ = 1 V to 11 V; $R_L$ ≥ 2 kΩ | | | | 50 | 100 | | V/mV |
| | | | | | $T_A$ = –55°C to 125°C | 25 | | | |
| **FREQUENCY RESPONSE** | | | | | | | | | |
| GBW | Gain bandwidth product | | | | | | 0.7 | | MHz |
| SR | Slew rate | G = +1 | | | | | 0.3 | | V/µs |
| **OUTPUT** | | | | | | | | | |
| $V_O$ | Voltage output swing from rail | Positive rail | $V_S$ = 30 V; $R_L$ = 2 kΩ | | $T_A$ = –55°C to 125°C | | | 4 | V |
| | | | $V_S$ = 30 V; $R_L$ ≥ 10 kΩ | | | | 2 | 3 | |
| | | | $V_S$ = 5 V; $R_L$ ≥ 2 kΩ | | | | | 1.5 | |
| | | Negative rail | $V_S$ = 5 V; $R_L$ ≤ 10 kΩ | | $T_A$ = –55°C to 125°C | | 5 | 20 | mV |
| $I_O$ | Output current | $V_S$ = 15 V; $V_O$ = 0 V; $V_{ID}$ = 1 V | Source | | | –20 | –30 | | mA |
| | | | | LM158A | | | | –60 | |
| | | | | | $T_A$ = –55°C to 125°C | –10 | | | |
| | | $V_S$ = 15 V; $V_O$ = 15 V; $V_{ID}$ = –1 V | Sink | | | 10 | 20 | | |
| | | | | | $T_A$ = –55°C to 125°C | 5 | | | |
| | | $V_{ID}$ = –1 V; $V_O$ = 200 mV | | | | 12 | 30 | | µA |
| $I_{SC}$ | Short-circuit current | $V_S$ = 10 V; $V_O$ = $V_S$ / 2 | | | | | ±40 | ±60 | mA |
| **POWER SUPPLY** | | | | | | | | | |
| $I_Q$ | Quiescent current per amplifier | $V_O$ = 2.5 V; $I_O$ = 0 A | | | $T_A$ = –55°C to 125°C | | 350 | 600 | µA |
| | | $V_S$ = 30 V; $V_O$ = 15 V; $I_O$ = 0 A | | | | | 500 | 1000 | |

(1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. Maximum $V_S$ for testing purposes is 30 V for LM158 and LM158A.
(2) All typical values are $T_A$ = 25°C.
(3) On products compliant to MIL-PRF-38535, this parameter is not production tested.

## 7.10 Electrical Characteristics: LM258, LM258A

For $V_S$ = (V+) – (V–) = 5 V, $T_A$ = 25 °C, (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS[1] | | | MIN | TYP[2] | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| **OFFSET VOLTAGE** | | | | | | | | |
| $V_{OS}$ | Input offset voltage | $V_S$ = 5 V to 30 V; $V_{CM}$ = 0 V; $V_O$ = 1.4 V | LM258 | | | 3 | 5 | mV |
| | | | | $T_A$ = –25°C to 85°C | | | 7 | |
| | | | LM258A | | | 2 | 3 | |
| | | | | $T_A$ = –25°C to 85°C | | | 4 | |
| $dV_{OS}/d_T$ | Input offset voltage drift | | LM258 | $T_A$ = –25°C to 85°C | | 7 | | µV/°C |
| | | | LM258A | | | 7 | 15 | |
| PSRR | Input offset voltage vs power supply ($\Delta V_{IO}/\Delta V_S$) | $V_S$ = 5 V to 30 V | | | 65 | 100 | | dB |
| $V_{O1}$/ $V_{O2}$ | Channel separation | f = 1 kHz to 20 kHz | | | | 120 | | dB |
| **INPUT VOLTAGE RANGE** | | | | | | | | |
| $V_{CM}$ | Common-mode voltage range | $V_S$ = 5 V to 30 V | LM258 | | (V–) | | (V+) – 1.5 | V |
| | | $V_S$ = 30 V | LM258A | | | | | |
| | | $V_S$ = 5 V to 30 V | LM258 | $T_A$ = –25°C to 85°C | (V–) | | (V+) – 2 | |
| | | $V_S$ = 30 V | LM258A | | | | | |
| CMRR | Common-mode rejection ratio | $V_S$ = 5 V to 30 V; $V_{CM}$ = 0 V | | | 70 | 80 | | dB |
| **INPUT BIAS CURRENT** | | | | | | | | |
| $I_B$ | Input bias current | $V_O$ = 1.4 V | LM258 | | | –20 | –150 | nA |
| | | | | $T_A$ = –25°C to 85°C | | | –300 | |
| | | | LM258A | | | –15 | –80 | |
| | | | | $T_A$ = –25°C to 85°C | | | –100 | |
| $I_{OS}$ | Input offset current | $V_O$ = 1.4 V | LM258 | | | 2 | 30 | nA |
| | | | | $T_A$ = –25°C to 85°C | | | 100 | |
| | | | LM258A | | | 2 | 15 | |
| | | | | $T_A$ = –25°C to 85°C | | | 30 | |
| $dI_{OS}/d_T$ | Input offset current drift | | | | | 10 | | pA/°C |
| | | | LM258A | $T_A$ = –25°C to 85°C | | | 200 | |
| **NOISE** | | | | | | | | |
| $e_n$ | Input voltage noise density | f = 1 kHz | | | | 40 | | nV/√Hz |
| **OPEN-LOOP GAIN** | | | | | | | | |
| $A_{OL}$ | Open-loop voltage gain | $V_S$ = 15 V; $V_O$ = 1 V to 11 V; $R_L$ ≥ 2 kΩ | | | 50 | 100 | | V/mV |
| | | | | $T_A$ = –25°C to 85°C | 25 | | | |
| **FREQUENCY RESPONSE** | | | | | | | | |
| GBW | Gain bandwidth product | | | | | 0.7 | | MHz |
| SR | Slew rate | G = +1 | | | | 0.3 | | V/µs |
| **OUTPUT** | | | | | | | | |
| $V_O$ | Voltage output swing from rail | Positive rail | $V_S$ = 30 V; $R_L$ = 2 kΩ | $T_A$ = –25°C to 85°C | | | 4 | V |
| | | | $V_S$ = 30 V; $R_L$ ≥ 10 kΩ | | | 2 | 3 | |
| | | | $V_S$ = 5 V; $R_L$ ≥ 2 kΩ | | | | 1.5 | |
| | | Negative rail | $V_S$ = 5 V; $R_L$ ≤ 10 kΩ | $T_A$ = –25°C to 85°C | | 5 | 20 | mV |
| $I_O$ | Output current | $V_S$ = 15 V; $V_O$ = 0 V; $V_{ID}$ = 1 V | Source | | –20 | –30 | | mA |
| | | | | LM258A | | | –60 | |
| | | | | $T_A$ = –25°C to 85°C | –10 | | | |
| | | $V_S$ = 15 V; $V_O$ = 15 V; $V_{ID}$ = –1 V | Sink | | 10 | 20 | | |
| | | | | $T_A$ = –25°C to 85°C | 5 | | | |
| | | $V_{ID}$ = –1 V; $V_O$ = 200 mV | | | 12 | 30 | | µA |
| $I_{SC}$ | Short-circuit current | $V_S$ = 10 V; $V_O$ = $V_S$ / 2 | | | | ±40 | ±60 | mA |
| **POWER SUPPLY** | | | | | | | | |
| $I_Q$ | Quiescent current per amplifier | $V_O$ = 2.5 V; $I_O$ = 0 A | | $T_A$ = –25°C to 85°C | | 350 | 600 | µA |
| | | $V_S$ = 30 V; $V_O$ = 15 V; $I_O$ = 0 A | | | | 500 | 1000 | |

(1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. Maximum $V_S$ for testing purposes is 30 V for LM258 and LM258A.
(2) All typical values are $T_A$ = 25°C.

## 7.11 Typical Characteristics

Typical characteristics section is applicable for LM358B and LM2904B. The typical characteristics data section was taken with $T_A$ = 25°C, $V_S$ = 36 V (±18 V), $V_{CM}$ = $V_S$ / 2, $R_{LOAD}$ = 10 kΩ connected to $V_S$ / 2 (unless otherwise noted).

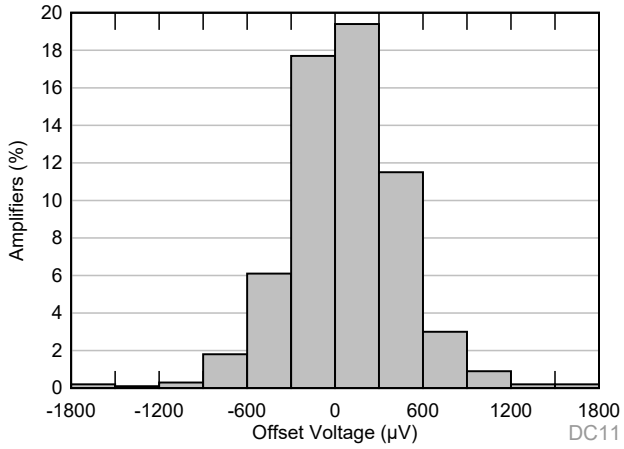



**Figure 1. Offset Voltage Production Distribution**

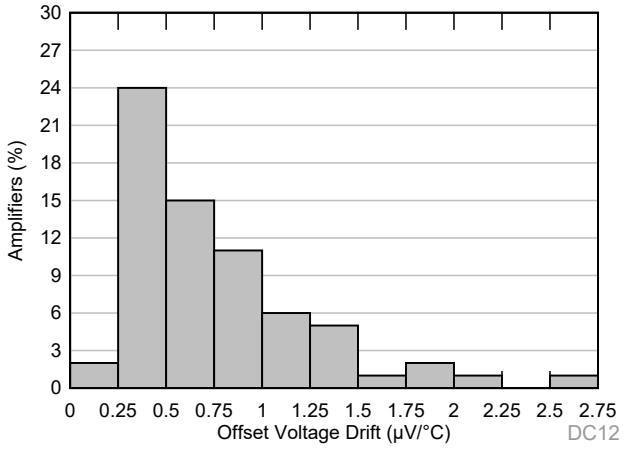



**Figure 2. Offset Voltage Drift Distribution**

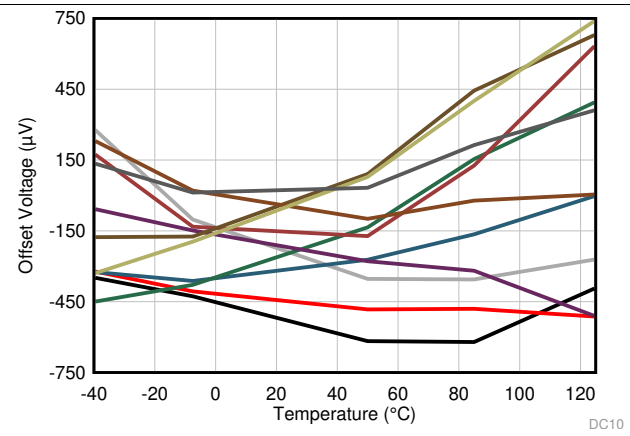



**Figure 3. Offset Voltage vs Temperature**

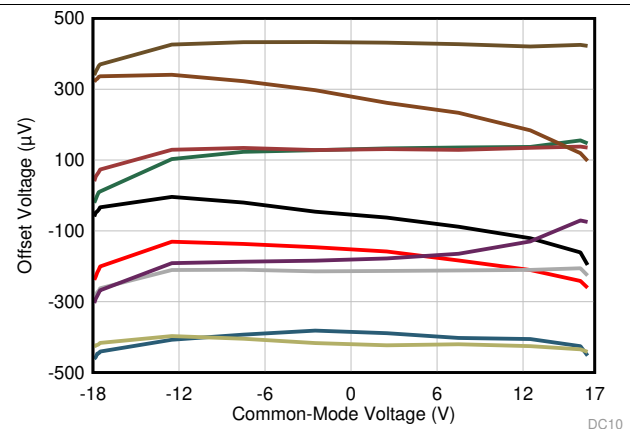



**Figure 4. Offset Voltage vs Common-Mode Voltage**

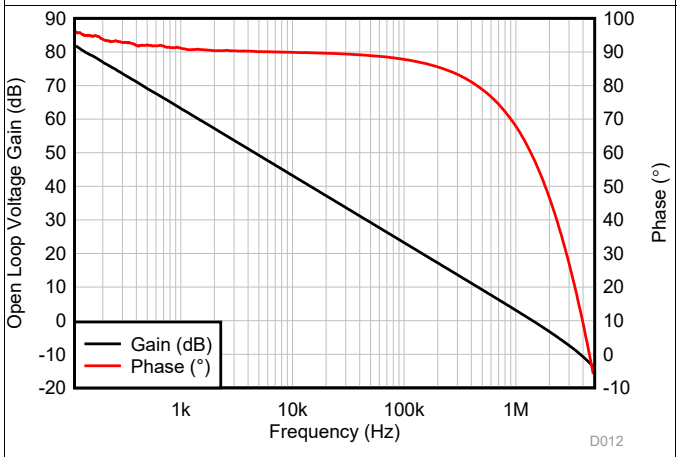



**Figure 5. Open-Loop Gain and Phase vs Frequency**

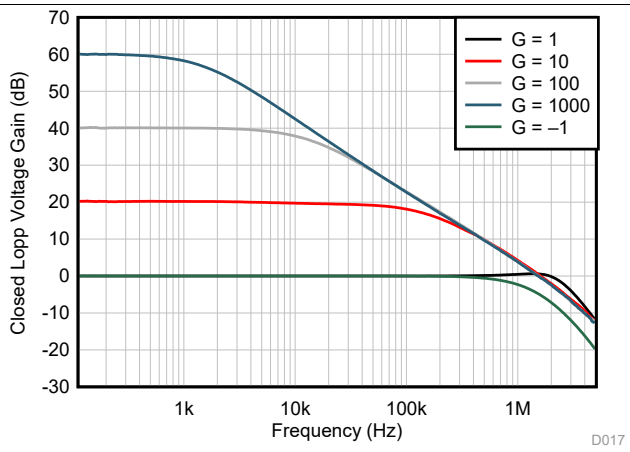



**Figure 6. Closed-Loop Gain vs Frequency**

## Typical Characteristics (continued)

Typical characteristics section is applicable for LM358B and LM2904B. The typical characteristics data section was taken with $T_A$ = 25°C, $V_S$ = 36 V (±18 V), $V_{CM}$ = $V_S$ / 2, $R_{LOAD}$ = 10 kΩ connected to $V_S$ / 2 (unless otherwise noted).

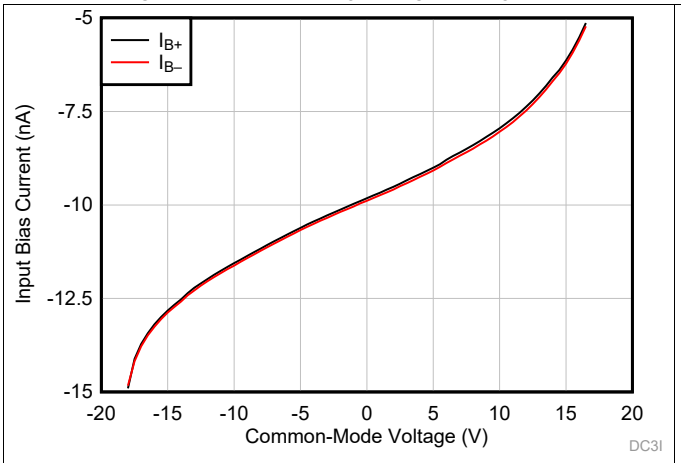



**Figure 7. Input Bias Current vs Common-Mode Voltage**

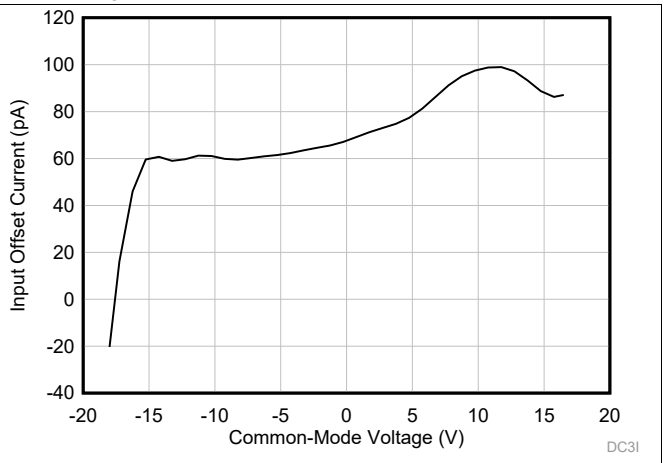



**Figure 8. Input Offset Current vs Common-Mode Voltage**

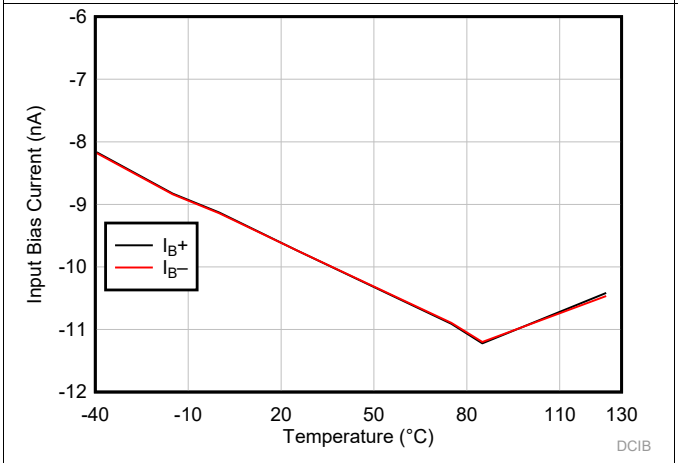



**Figure 9. Input Bias Current vs Temperature**

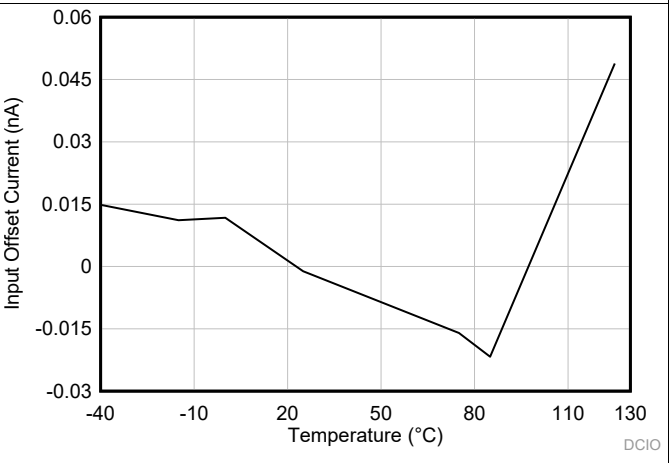



**Figure 10. Input Offset Current vs Temperature**

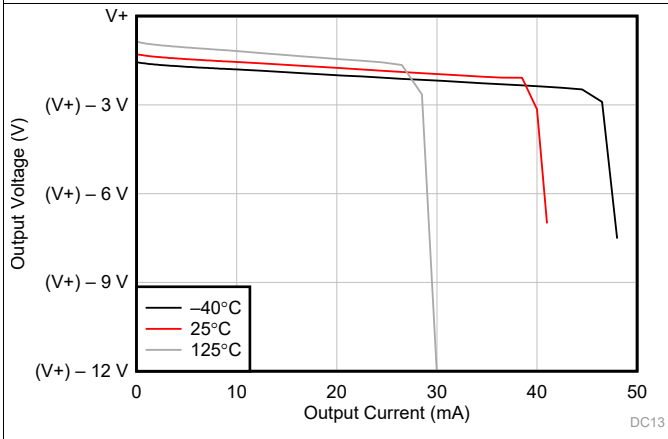



**Figure 11. Output Voltage Swing vs Output Current (Sourcing)**

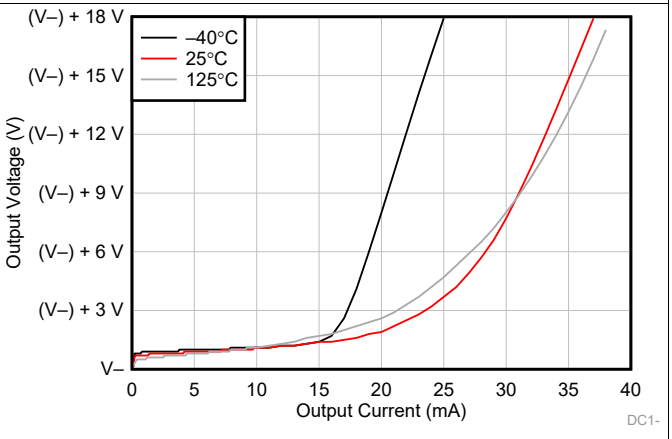



**Figure 12. Output Voltage Swing vs Output Current (Sinking)**

## Typical Characteristics (continued)

Typical characteristics section is applicable for LM358B and LM2904B. The typical characteristics data section was taken with $T_A$ = 25°C, $V_S$ = 36 V (±18 V), $V_{CM}$ = $V_S$ / 2, $R_{LOAD}$ = 10 kΩ connected to $V_S$ / 2 (unless otherwise noted).

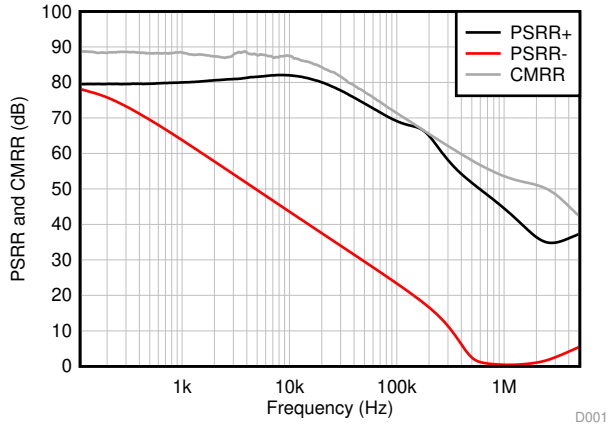



**Figure 13. CMRR and PSRR vs Frequency**

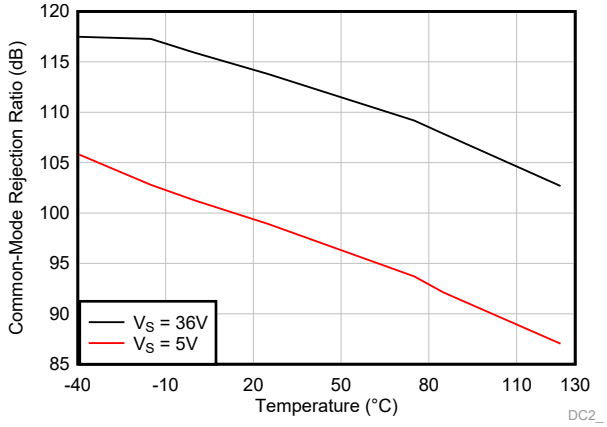
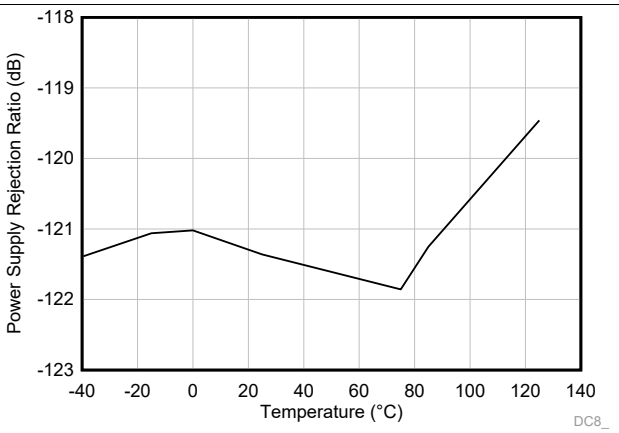



**Figure 14. Common-Mode Rejection Ratio vs Temperature (dB)**




$V_S$ = 5 V to 36 V

**Figure 15. Power Supply Rejection Ratio vs Temperature (dB)**

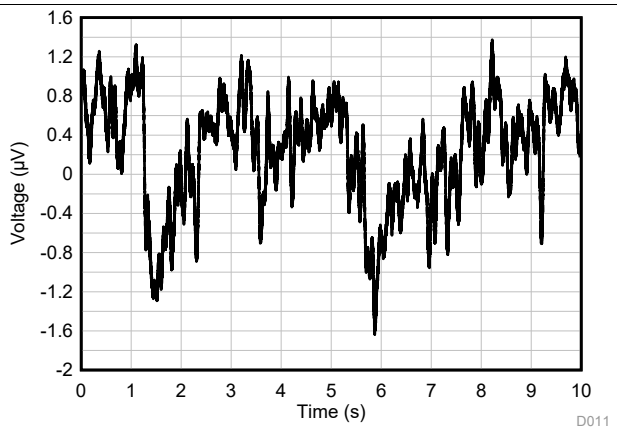



**Figure 16. 0.1-Hz to 10-Hz Noise**

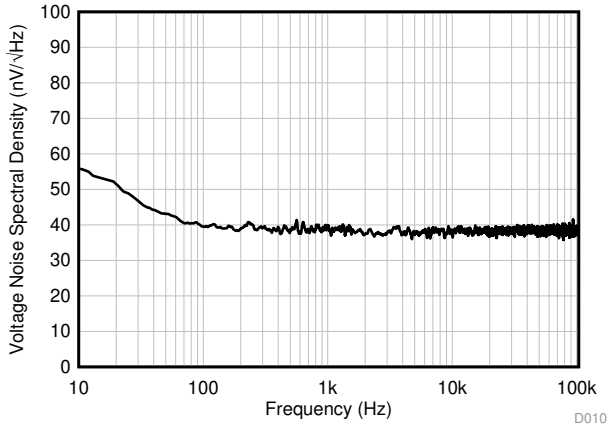
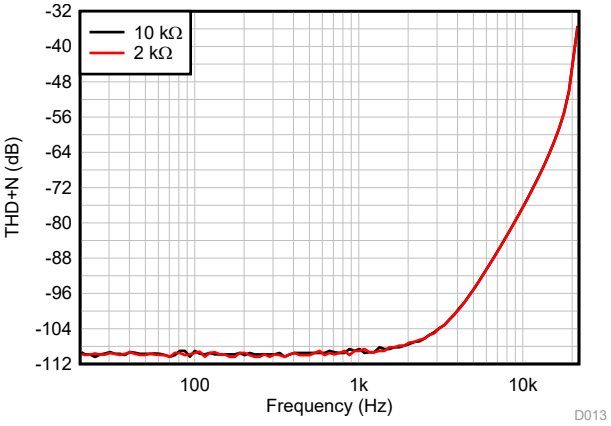



**Figure 17. Input Voltage Noise Spectral Density vs Frequency**

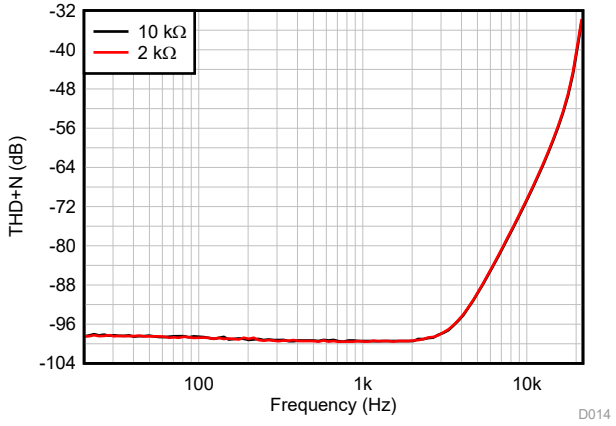



G = 1, f = 1 kHz, BW = 80 kHz,
$V_{OUT}$ = 10 $V_{PP}$, $R_L$ connected to V–

**Figure 18. THD+N Ratio vs Frequency, G = 1**

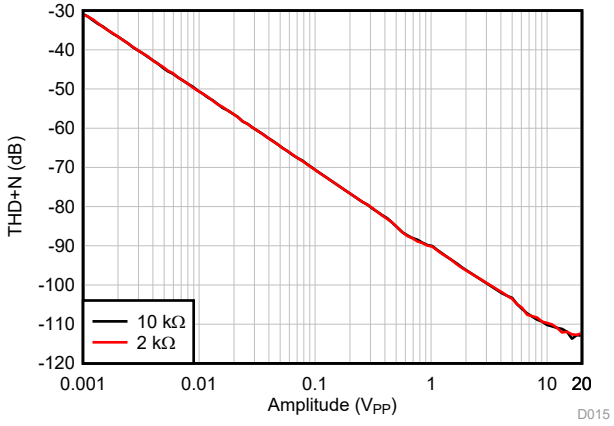
## Typical Characteristics (continued)

Typical characteristics section is applicable for LM358B and LM2904B. The typical characteristics data section was taken with $T_A$ = 25°C, $V_S$ = 36 V (±18 V), $V_{CM}$ = $V_S$ / 2, $R_{LOAD}$ = 10 kΩ connected to $V_S$ / 2 (unless otherwise noted).



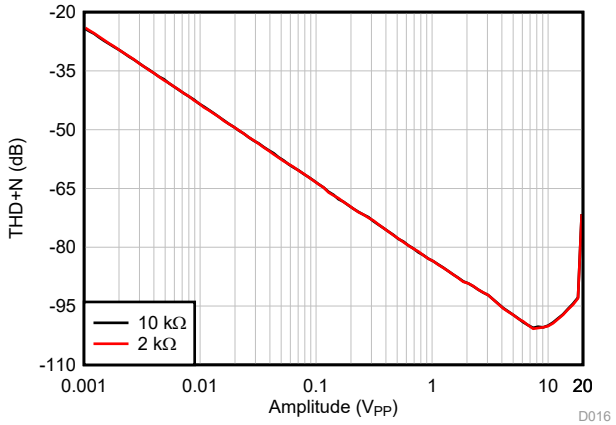

G = –1, f = 1 kHz, BW = 80 kHz,
$V_{OUT}$ = 10 $V_{PP}$, $R_L$ connected to V–

**Figure 19. THD+N Ratio vs Frequency, G = –1**




G = 1, f = 1 kHz, BW = 80 kHz,
$R_L$ connected to V–

**Figure 20. THD+N vs Output Amplitude, G = 1**




G = –1, f = 1 kHz, BW = 80 kHz,
$R_L$ connected to V–

**Figure 21. THD+N vs Output Amplitude, G = –1**

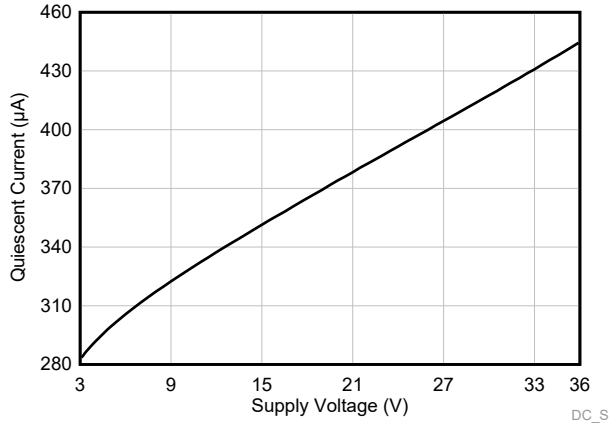



**Figure 22. Quiescent Current vs Supply Voltage**

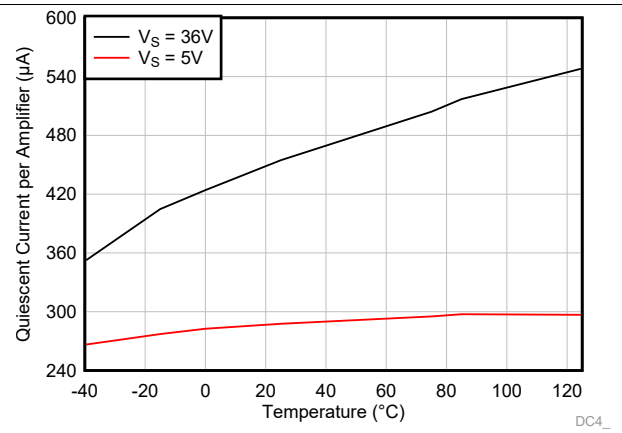



**Figure 23. Quiescent Current vs Temperature**

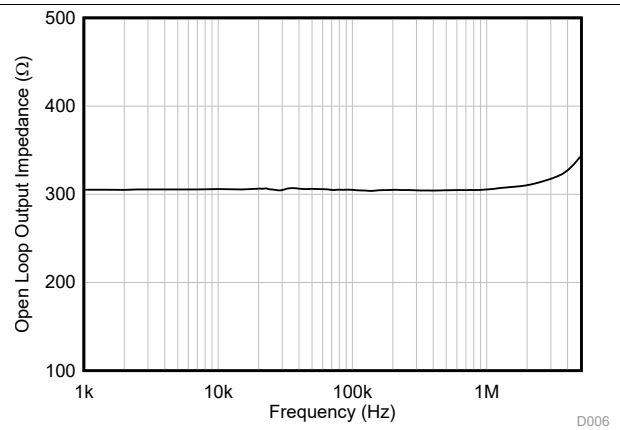
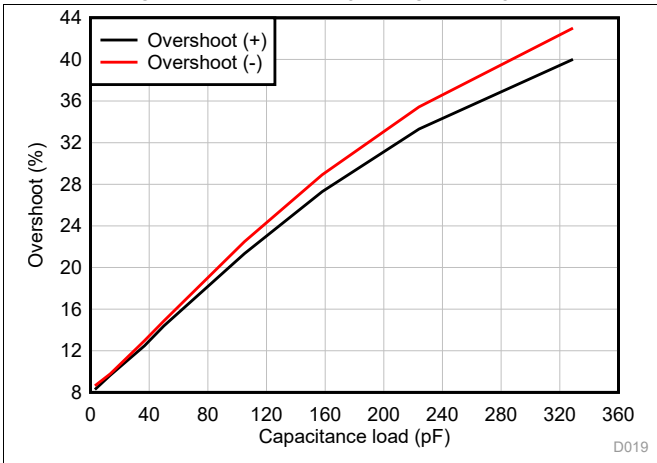



**Figure 24. Open-Loop Output Impedance vs Frequency**

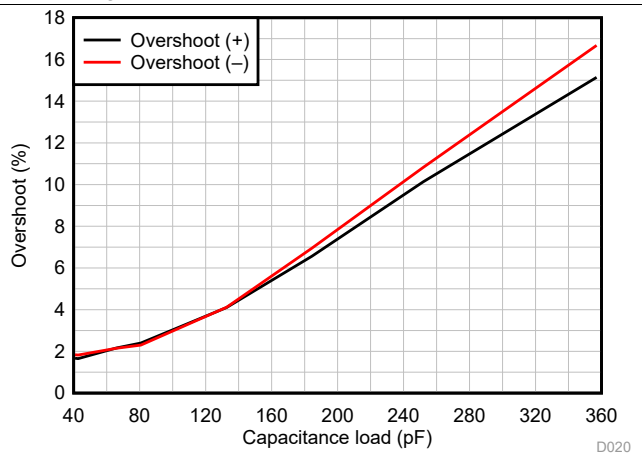
## Typical Characteristics (continued)

Typical characteristics section is applicable for LM358B and LM2904B. The typical characteristics data section was taken with $T_A$ = 25°C, $V_S$ = 36 V (±18 V), $V_{CM}$ = $V_S$ / 2, $R_{LOAD}$ = 10 kΩ connected to $V_S$ / 2 (unless otherwise noted).




G = 1, 100-mV output step, $R_L$ = open

**Figure 25. Small-Signal Overshoot vs Capacitive Load**




G = –1, 100-mV output step, $R_L$ = open

**Figure 26. Small-Signal Overshoot vs Capacitive Load**

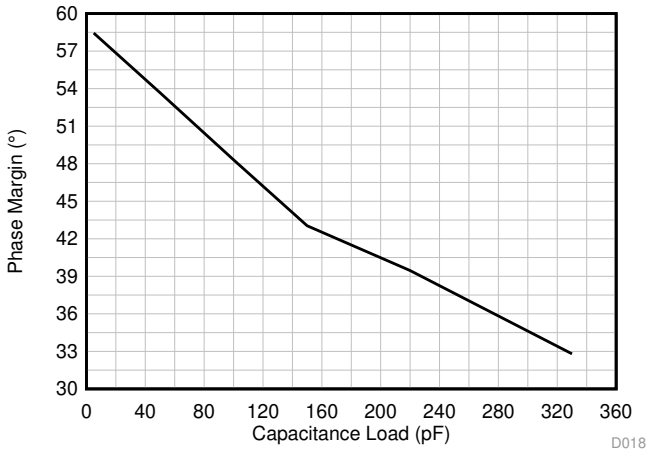
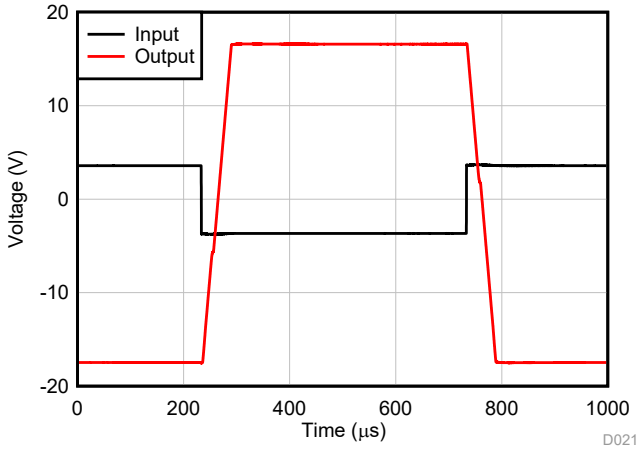
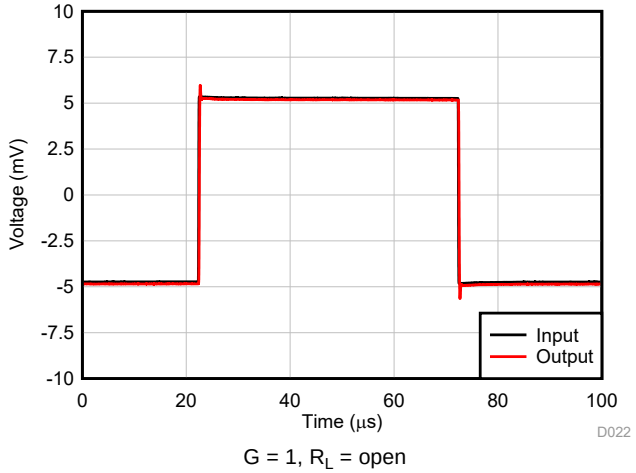



**Figure 27. Phase Margin vs Capacitive Load**



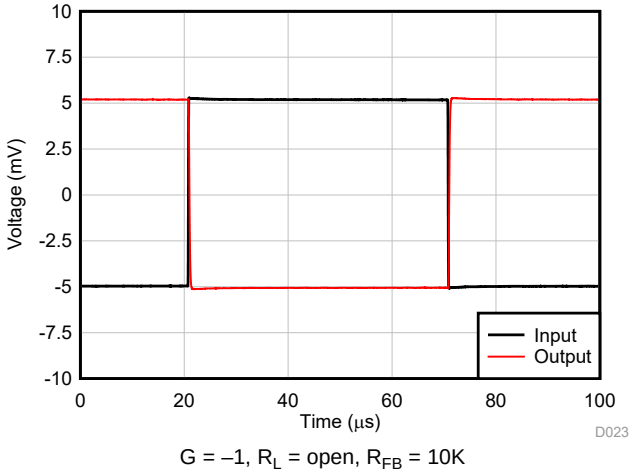

G = –10

**Figure 28. Overload Recovery**




G = 1, $R_L$ = open

**Figure 29. Small-Signal Step Response, G = 1**

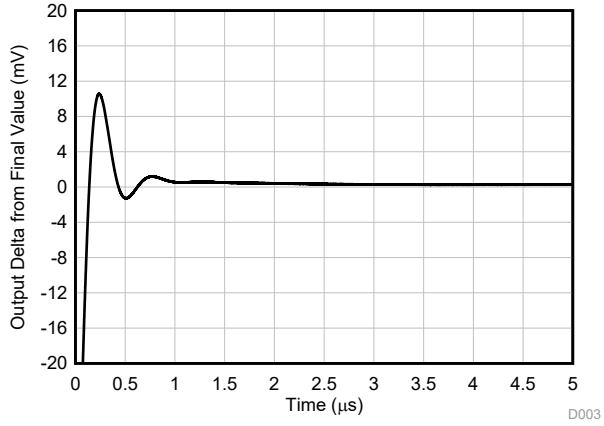



G = –1, $R_L$ = open, $R_{FB}$ = 10K

**Figure 30. Small-Signal Step Response, G = –1**

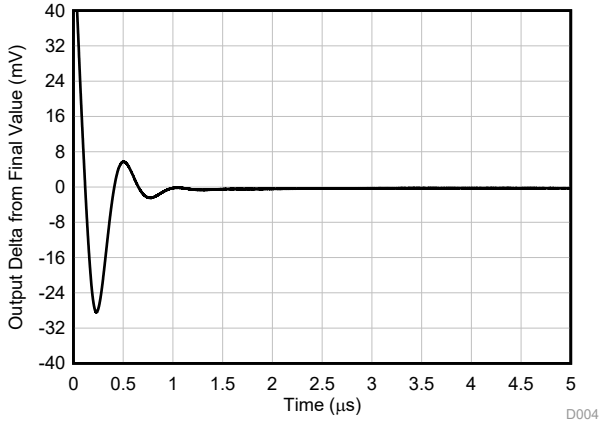
## Typical Characteristics (continued)

Typical characteristics section is applicable for LM358B and LM2904B. The typical characteristics data section was taken with $T_A$ = 25°C, $V_S$ = 36 V (±18 V), $V_{CM}$ = $V_S$ / 2, $R_{LOAD}$ = 10 kΩ connected to $V_S$ / 2 (unless otherwise noted).



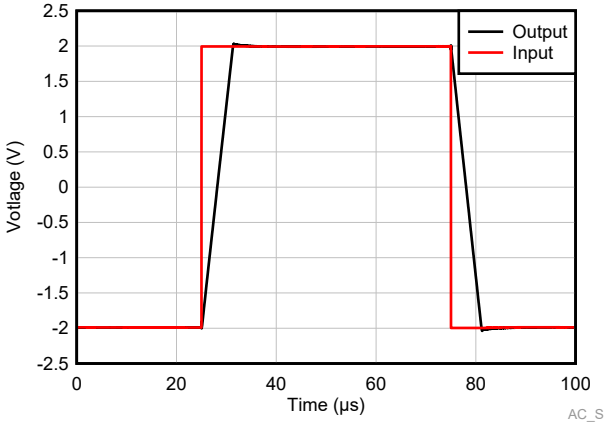

G = 1, $R_L$ = open

**Figure 31. Large-Signal Step Response (Rising)**




G = 1, $R_L$ = open

**Figure 32. Large-Signal Step Response (Falling)**




G = 1, $R_L$ = open

**Figure 33. Large-Signal Step Response**

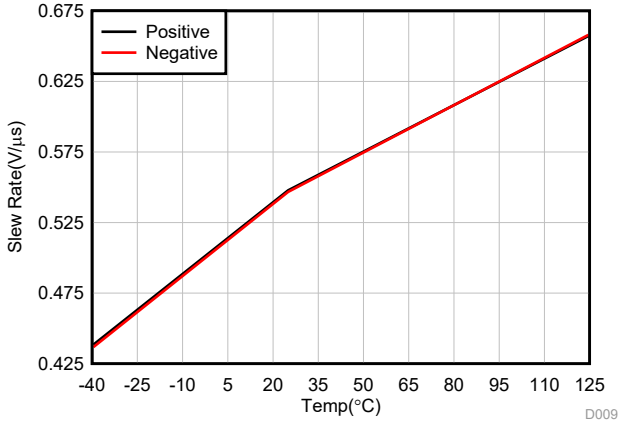



**Figure 34. Slew Rate vs Temperature**

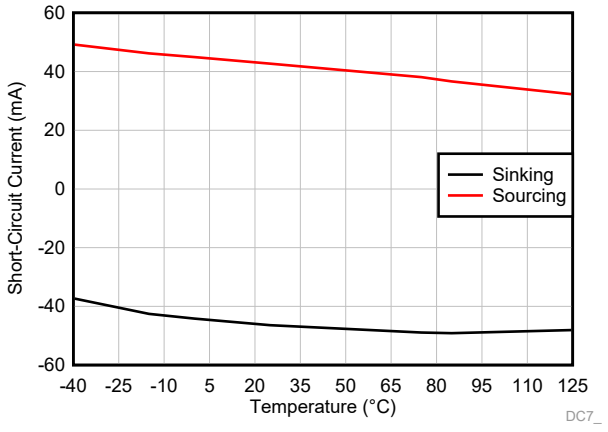
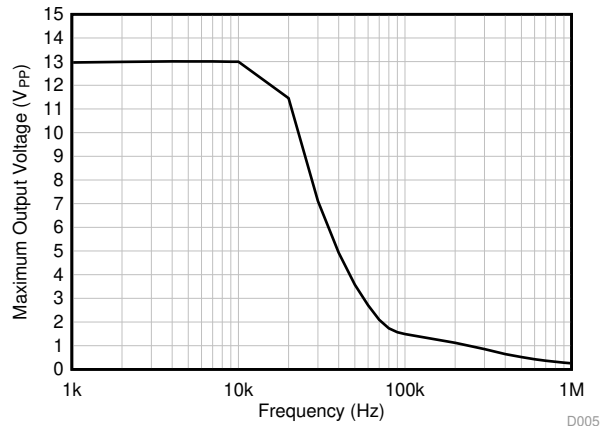



**Figure 35. Short-Circuit Current vs Temperature**




$V_S$ = 15 V

**Figure 36. Maximum Output Voltage vs Frequency**

## Typical Characteristics (continued)

Typical characteristics section is applicable for LM358B and LM2904B. The typical characteristics data section was taken with $T_A$ = 25°C, $V_S$ = 36 V (±18 V), $V_{CM}$ = $V_S$ / 2, $R_{LOAD}$ = 10 kΩ connected to $V_S$ / 2 (unless otherwise noted).

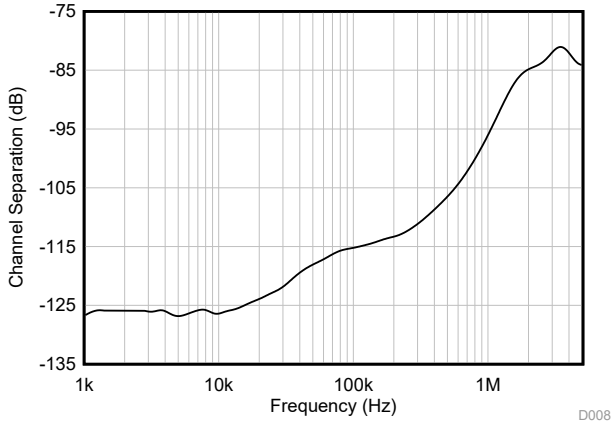



**Figure 37. Channel Separation vs Frequency**

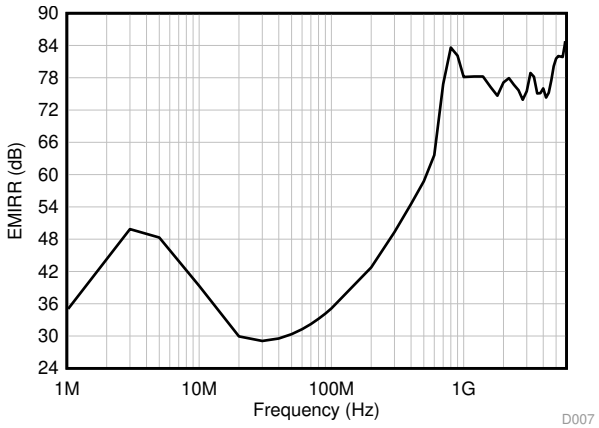



**Figure 38. EMIRR (Electromagnetic Interference Rejection Ratio) vs Frequency**

## 7.12 Typical Characteristics

Typical characteristics section is applicable for LM158, LM158A, LM258, LM258A, LM358, LM358A, LM2904, and LM2904V.

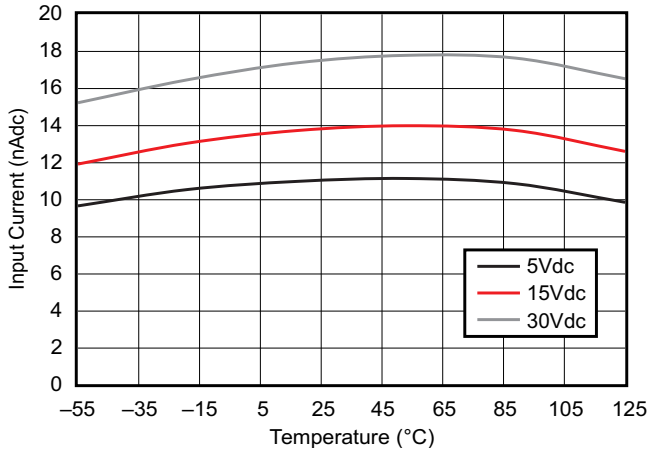



**Figure 39. Input Current vs Temperature**

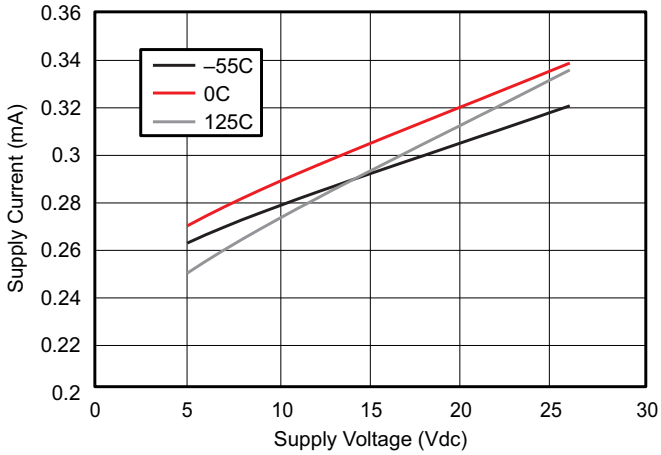



**Figure 40. Supply Current vs Supply Voltage**

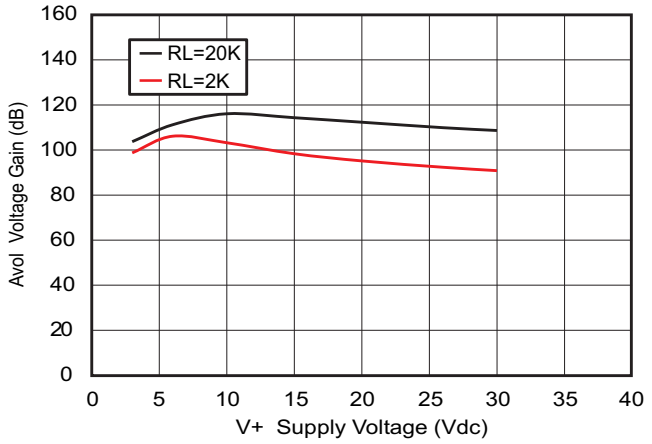



**Figure 41. Voltage Gain vs Supply Voltage**

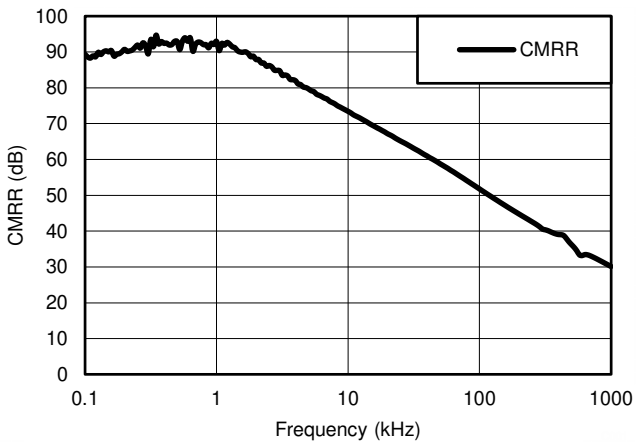



**Figure 42. Common-Mode Rejection Ratio vs Frequency**

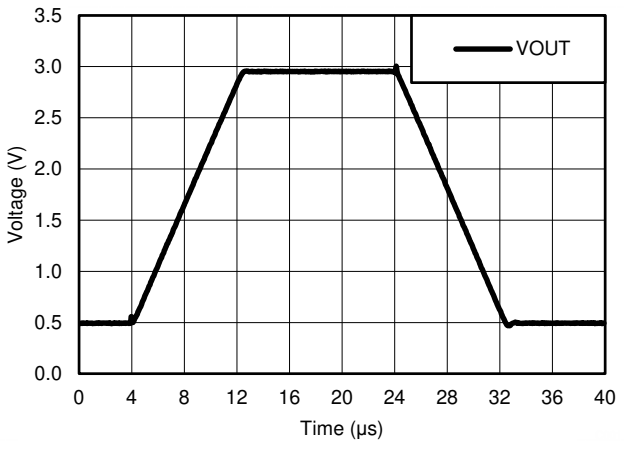



**Figure 43. Voltage Follower Large Signal Response (50 pF)**

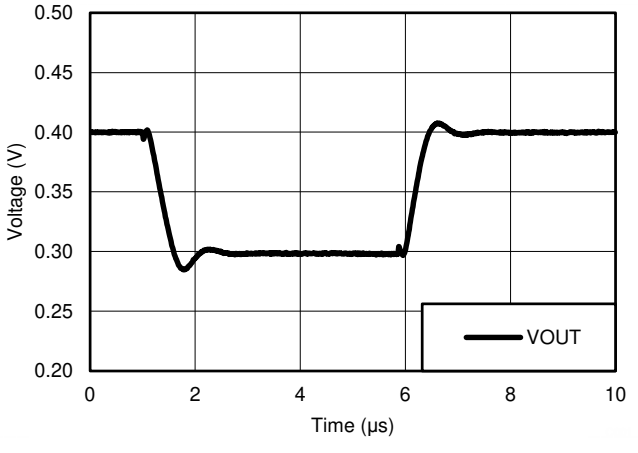



**Figure 44. Voltage Follower Small Signal Response (50 pF)**

## Typical Characteristics (continued)

Typical characteristics section is applicable for LM158, LM158A, LM258, LM258A, LM358, LM358A, LM2904, and LM2904V.

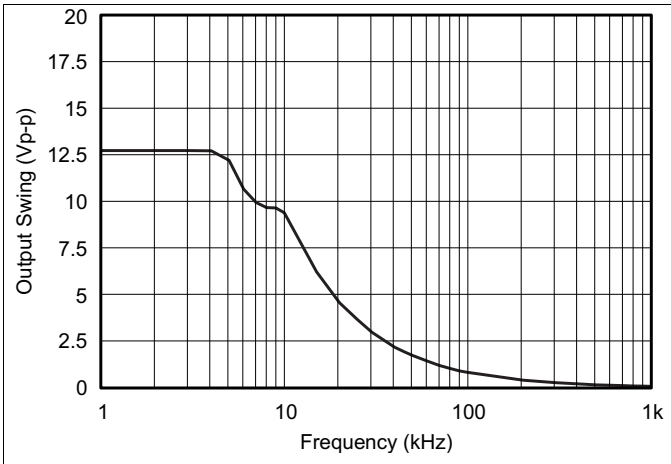



**Figure 45. Maximum Output Swing vs Frequency ($V_{CC}$ = 15 V)**

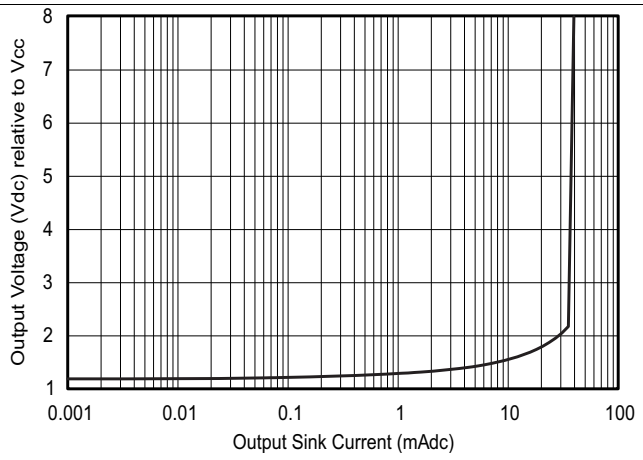



**Figure 46. Output Sourcing Characteristics**

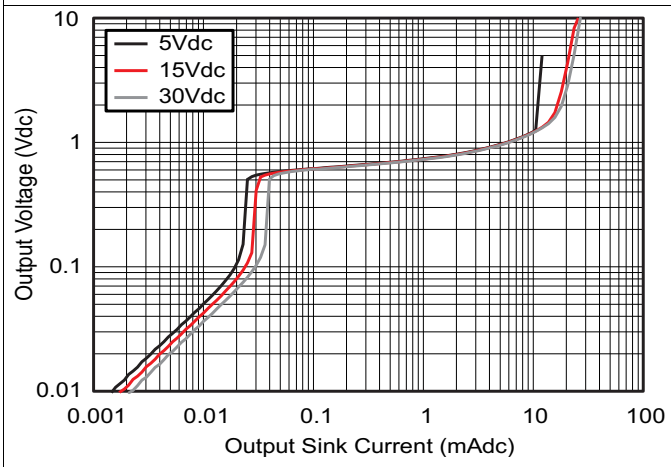



**Figure 47. Output Sinking Characteristics**

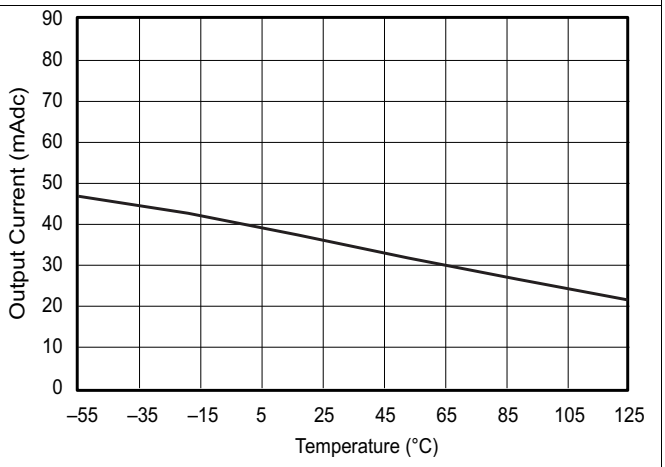



**Figure 48. Source Current Limiting**

# 8 Parameter Measurement Information

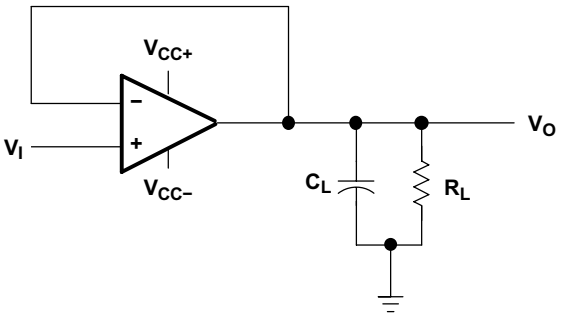



Figure 49. Unity-Gain Amplifier

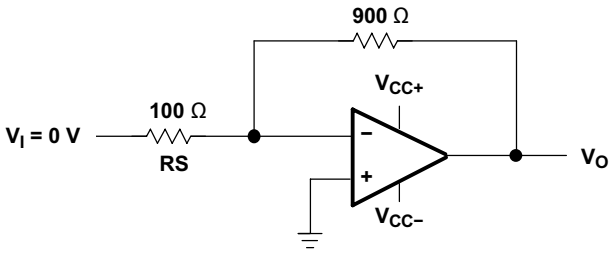



Figure 50. Noise-Test Circuit

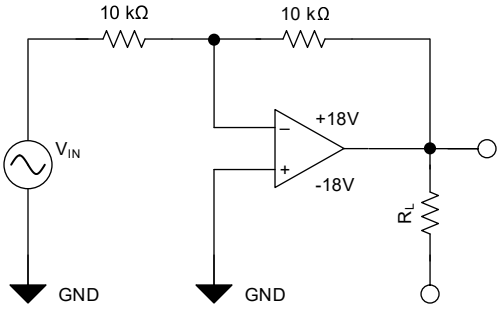



Figure 51. Test Circuit, G = –1, for THD+N and Small-Signal Step Response

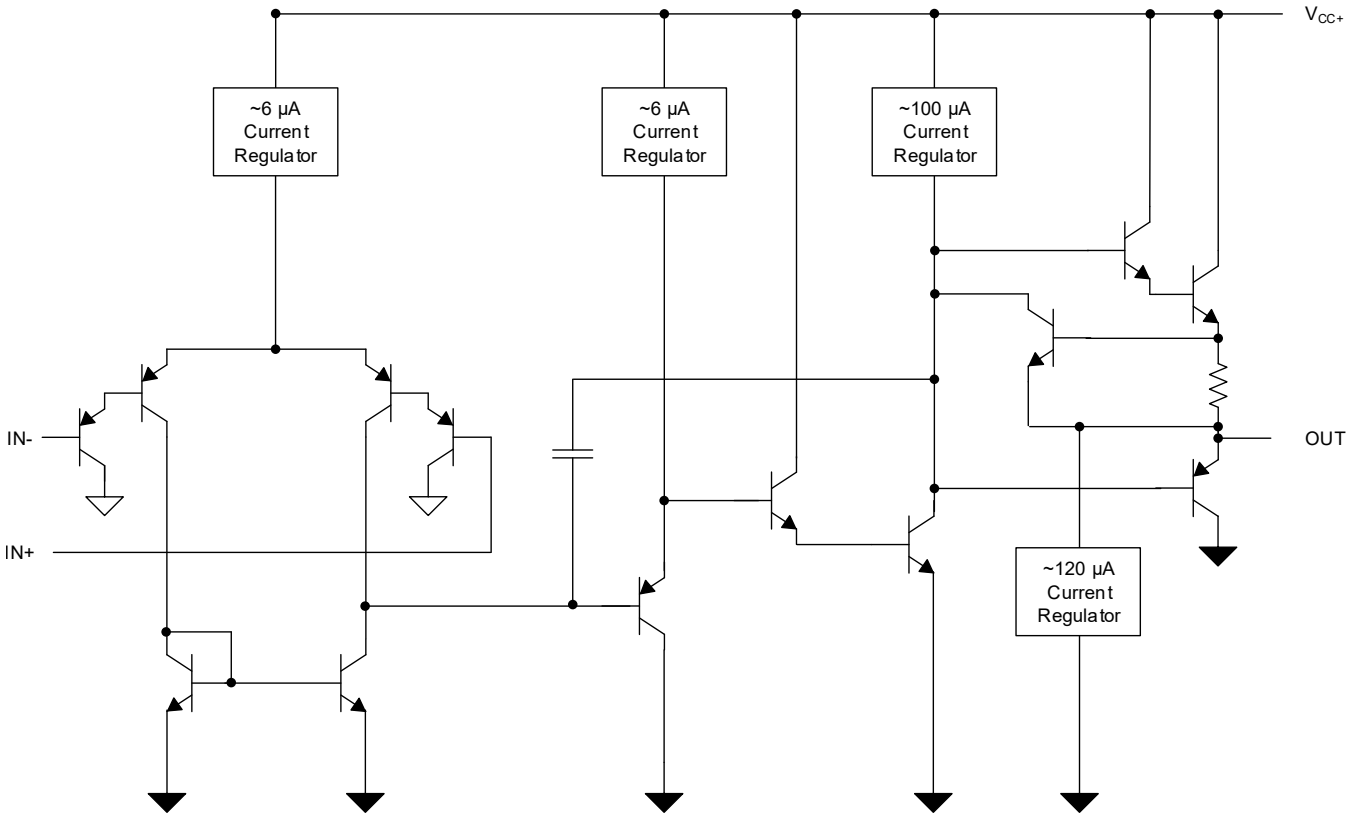
# 9 Detailed Description

## 9.1 Overview

These devices consist of two independent, high-gain frequency-compensated operational amplifiers designed to operate from a single supply over a wide range of voltages. Operation from split supplies also is possible if the difference between the two supplies is within the supply voltage range specified in the *Recommended Operating Conditions* section, and $V_S$ is at least 1.5 V more positive than the input common-mode voltage. The low supply-current drain is independent of the magnitude of the supply voltage.

Applications include transducer amplifiers, dc amplification blocks, and all the conventional operational amplifier circuits that now can be implemented more easily in single-supply-voltage systems. For example, these devices can be operated directly from the standard 5-V supply used in digital systems and easily can provide the required interface electronics without additional ±5-V supplies.

## 9.2 Functional Block Diagram - LM358B, LM358BA, LM2904B, LM2904BA



## 9.3 Feature Description

### 9.3.1 Unity-Gain Bandwidth

The unity-gain bandwidth is the frequency up to which an amplifier with a unity gain may be operated without greatly distorting the signal. These devices have a 1.2-MHz unity-gain bandwidth (B Version).

### 9.3.2 Slew Rate

The slew rate is the rate at which an operational amplifier can change its output when there is a change on the input. These devices have a 0.5-V/µs slew rate (B Version).

### 9.3.3 Input Common Mode Range

The valid common mode range is from device ground to $V_S$ – 1.5 V ($V_S$ – 2 V across temperature). Inputs may exceed $V_S$ up to the maximum $V_S$ without device damage. At least one input must be in the valid input common-mode range for the output to be the correct phase. If both inputs exceed the valid range, then the output phase is undefined. If either input more than 0.3 V below V– then input current should be limited to 1 mA and the output phase is undefined.

## 9.4 Device Functional Modes

These devices are powered on when the supply is connected. This device can be operated as a single-supply operational amplifier or dual-supply amplifier, depending on the application.

# 10 Application and Implementation

**NOTE**

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

## 10.1 Application Information

The LMx58 and LM2904 operational amplifiers are useful in a wide range of signal conditioning applications. Inputs can be powered before $V_S$ for flexibility in multiple supply circuits.

## 10.2 Typical Application

A typical application for an operational amplifier is an inverting amplifier. This amplifier takes a positive voltage on the input, and makes it a negative voltage of the same magnitude. In the same manner, it also makes negative voltages positive.

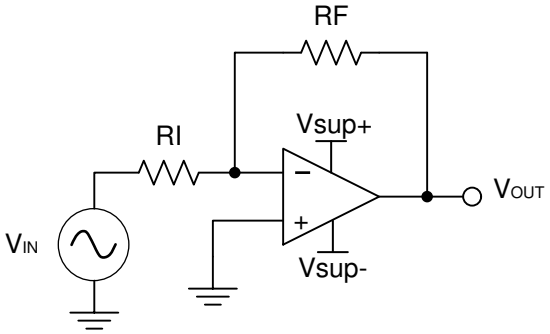



**Figure 52. Application Schematic**

### 10.2.1 Design Requirements

The supply voltage must be chosen such that it is larger than the input voltage range and output range. For instance, this application scales a signal of ±0.5 V to ±1.8 V. Setting the supply at ±12 V is sufficient to accommodate this application.

### 10.2.2 Detailed Design Procedure

Determine the gain required by the inverting amplifier using Equation 1 and Equation 2:

$$A_V = \frac{VOUT}{VIN} \tag{1}$$

$$A_V = \frac{1.8}{-0.5} = -3.6 \tag{2}$$

Once the desired gain is determined, choose a value for $R_I$ or $R_F$. [Subscripts should be fixed in the accompanying figures and equations also.] Choosing a value in the kilohm range is desirable because the amplifier circuit uses currents in the milliampere range. This ensures the part does not draw too much current. This example uses 10 kΩ for $R_I$ which means 36 kΩ is used for $R_F$. This was determined by Equation 3.

$$A_V = -\frac{RF}{RI} \tag{3}$$

## Typical Application (continued)

### 10.2.3 Application Curve

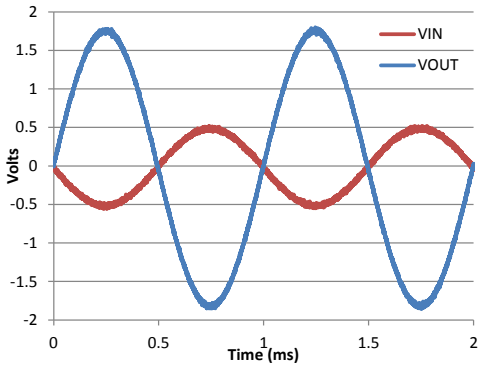



**Figure 53. Input and Output Voltages of the Inverting Amplifier**

# 11 Power Supply Recommendations

**CAUTION**

Supply voltages larger than specified in the recommended operating region can permanently damage the device (see the *Absolute Maximum Ratings*).

Place 0.1-µF bypass capacitors close to the power-supply pins to reduce errors coupling in from noisy or high-impedance power supplies. For more detailed information on bypass capacitor placement, see the *Layout* section.

# 12 Layout

## 12.1 Layout Guidelines

For best operational performance of the device, use good PCB layout practices, including:

- Noise can propagate into analog circuitry through the power pins of the circuit as a whole, as well as the operational amplifier. Bypass capacitors are used to reduce the coupled noise by providing low-impedance power sources local to the analog circuitry.
  - Connect low-ESR, 0.1-µF ceramic bypass capacitors between each supply pin and ground, placed as close to the device as possible. A single bypass capacitor from V+ to ground is applicable for single-supply applications.
- Separate grounding for analog and digital portions of circuitry is one of the simplest and most-effective methods of noise suppression. One or more layers on multilayer PCBs are usually devoted to ground planes. A ground plane helps distribute heat and reduces EMI noise pickup. Make sure to physically separate digital and analog grounds, paying attention to the flow of the ground current.
- To reduce parasitic coupling, run the input traces as far away from the supply or output traces as possible. If it is not possible to keep them separate, it is much better to cross the sensitive trace perpendicular as opposed to in parallel with the noisy trace. [Things in parallel never cross, by definition]
- Place the external components as close to the device as possible. Keeping $R_F$ and $R_G$ close to the inverting input minimizes parasitic capacitance, as shown in *Layout Examples*.
- Keep the length of input traces as short as possible. Always remember that the input traces are the most sensitive part of the circuit.
- Consider a driven, low-impedance guard ring around the critical traces. A guard ring can significantly reduce leakage currents from nearby traces that are at different potentials.

## 12.2 Layout Examples

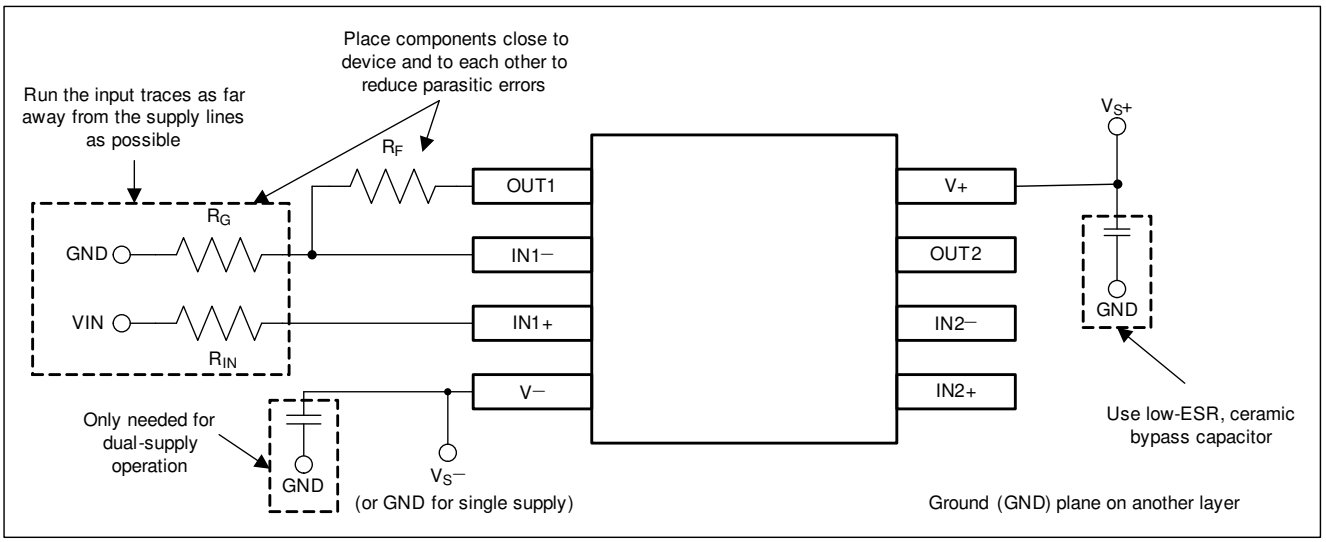



**Figure 54. Operational Amplifier Board Layout for Noninverting Configuration**

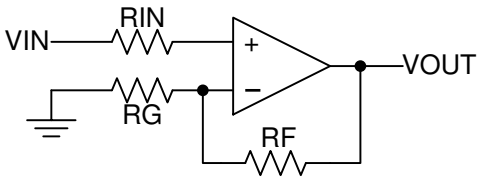



**Figure 55. Operational Amplifier Schematic for Noninverting Configuration**

# 13 Device and Documentation Support

## 13.1 Documentation Support

### 13.1.1 Related Documentation

- Texas Instruments, *Circuit Board Layout Techniques*.

## 13.2 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to order now.

**Table 1. Related Links**

| PARTS | PRODUCT FOLDER | ORDER NOW | TECHNICAL DOCUMENTS | TOOLS & SOFTWARE | SUPPORT & COMMUNITY |
|---|---|---|---|---|---|
| LM158 | Click here | Click here | Click here | Click here | Click here |
| LM158A | Click here | Click here | Click here | Click here | Click here |
| LM258 | Click here | Click here | Click here | Click here | Click here |
| LM258A | Click here | Click here | Click here | Click here | Click here |
| LM358 | Click here | Click here | Click here | Click here | Click here |
| LM358A | Click here | Click here | Click here | Click here | Click here |
| LM358B | Click here | Click here | Click here | Click here | Click here |
| LM2904 | Click here | Click here | Click here | Click here | Click here |
| LM2904B | Click here | Click here | Click here | Click here | Click here |
| LM2904V | Click here | Click here | Click here | Click here | Click here |

## 13.3 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

## 13.4 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

## 13.5 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

## 13.6 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## 13.7 Glossary

SLYZ022 — *TI Glossary.*

This glossary lists and explains terms, acronyms and definitions.

## 14 Mechanical, Packaging, and Orderable Information

The following pages include mechanical packaging and orderable information. This information is the most-current data available for the designated devices. This data is subject to change without notice and without revision of this document. For browser based versions of this data sheet, see the left-hand navigation pane.

## 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5962-87710012A | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type | -55 to 125 | 5962-87710012A LM158FKB | Samples |
| 5962-8771001PA | ACTIVE | CDIP | JG | 8 | 1 | TBD | Call TI | N / A for Pkg Type | -55 to 125 | 8771001PA LM158 | Samples |
| 5962-87710022A | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type | -55 to 125 | 5962-87710022A LM158AFKB | Samples |
| 5962-8771002PA | ACTIVE | CDIP | JG | 8 | 1 | TBD | Call TI | N / A for Pkg Type | -55 to 125 | 8771002PA LM158A | Samples |
| LM158 MW8 | ACTIVE | WAFERSALE | YS | 0 | 1 | Green (RoHS & no Sb/Br) | Call TI | Level-1-NA-UNLIM | -55 to 125 | | Samples |
| LM158AFKB | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type | -55 to 125 | 5962-87710022A LM158AFKB | Samples |
| LM158AJG | ACTIVE | CDIP | JG | 8 | 1 | TBD | Call TI | N / A for Pkg Type | -55 to 125 | LM158AJG | Samples |
| LM158AJGB | ACTIVE | CDIP | JG | 8 | 1 | TBD | Call TI | N / A for Pkg Type | -55 to 125 | 8771002PA LM158A | Samples |
| LM158FKB | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type | -55 to 125 | 5962-87710012A LM158FKB | Samples |
| LM158JG | ACTIVE | CDIP | JG | 8 | 1 | TBD | Call TI | N / A for Pkg Type | -55 to 125 | LM158JG | Samples |
| LM158JGB | ACTIVE | CDIP | JG | 8 | 1 | TBD | Call TI | N / A for Pkg Type | -55 to 125 | 8771001PA LM158 | Samples |
| LM258AD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -25 to 85 | LM258A | Samples |
| LM258ADGKR | ACTIVE | VSSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU \| NIPDAUAG | Level-1-260C-UNLIM | -25 to 85 | (M3L, M3P, M3S, M3U) | Samples |
| LM258ADR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU \| SN | Level-1-260C-UNLIM | -25 to 85 | LM258A | Samples |
| LM258ADRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -25 to 85 | LM258A | Samples |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LM258ADRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -25 to 85 | LM258A | Samples |
| LM258AP | ACTIVE | PDIP | P | 8 | 50 | Green (RoHS & no Sb/Br) | NIPDAU \| SN | N / A for Pkg Type | -25 to 85 | LM258AP | Samples |
| LM258APE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | NIPDAU | N / A for Pkg Type | -25 to 85 | LM258AP | Samples |
| LM258D | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -25 to 85 | LM258 | Samples |
| LM258DG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -25 to 85 | LM258 | Samples |
| LM258DGKR | ACTIVE | VSSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU \| NIPDAUAG | Level-1-260C-UNLIM | -25 to 85 | (M2L, M2P, M2S, M2U) | Samples |
| LM258DGKRG4 | ACTIVE | VSSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -25 to 85 | (M2L, M2P, M2S, M2U) | Samples |
| LM258DR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU \| SN | Level-1-260C-UNLIM | -25 to 85 | LM258 | Samples |
| LM258DRG3 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | SN | Level-1-260C-UNLIM | -25 to 85 | LM258 | Samples |
| LM258DRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -25 to 85 | LM258 | Samples |
| LM258P | ACTIVE | PDIP | P | 8 | 50 | Green (RoHS & no Sb/Br) | NIPDAU \| SN | N / A for Pkg Type | -25 to 85 | LM258P | Samples |
| LM258PE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | NIPDAU | N / A for Pkg Type | -25 to 85 | LM258P | Samples |
| LM2904AVQDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | L2904AV | Samples |
| LM2904AVQDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | L2904AV | Samples |
| LM2904AVQPWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | L2904AV | Samples |
| LM2904AVQPWRG4 | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | L2904AV | Samples |
| LM2904BAIDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 2904BA | Samples |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LM2904BIDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | L2904B | Samples |
| LM2904BIPWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | L2904B | Samples |
| LM2904D | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | LM2904 | Samples |
| LM2904DE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | LM2904 | Samples |
| LM2904DG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | LM2904 | Samples |
| LM2904DGKR | ACTIVE | VSSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU \| NIPDAUAG | Level-1-260C-UNLIM | -40 to 125 | (MBL, MBP, MBS, MBU) | Samples |
| LM2904DGKRG4 | ACTIVE | VSSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (MBL, MBP, MBS, MBU) | Samples |
| LM2904DR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | LM2904 | Samples |
| LM2904DRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | LM2904 | Samples |
| LM2904DRG3 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | SN | Level-1-260C-UNLIM | -40 to 125 | LM2904 | Samples |
| LM2904DRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | LM2904 | Samples |
| LM2904P | ACTIVE | PDIP | P | 8 | 50 | Green (RoHS & no Sb/Br) | NIPDAU \| SN | N / A for Pkg Type | -40 to 125 | LM2904P | Samples |
| LM2904PE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | NIPDAU | N / A for Pkg Type | -40 to 125 | LM2904P | Samples |
| LM2904PSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | L2904 | Samples |
| LM2904PW | ACTIVE | TSSOP | PW | 8 | 150 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | L2904 | Samples |
| LM2904PWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU \| SN | Level-1-260C-UNLIM | -40 to 125 | L2904 | Samples |
| LM2904PWRG3 | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | SN | Level-1-260C-UNLIM | -40 to 125 | L2904 | Samples |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LM2904PWRG4-JF | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | L2904 | Samples |
| LM2904QDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2904Q1 | Samples |
| LM2904QDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2904Q1 | Samples |
| LM2904VQDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | L2904V | Samples |
| LM2904VQDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | L2904V | Samples |
| LM2904VQPWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | L2904V | Samples |
| LM2904VQPWRG4 | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | L2904V | Samples |
| LM358AD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | LM358A | Samples |
| LM358ADE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | LM358A | Samples |
| LM358ADG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | LM358A | Samples |
| LM358ADGKR | ACTIVE | VSSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU \| NIPDAUAG | Level-1-260C-UNLIM | 0 to 70 | (M6L, M6P, M6S, M6U) | Samples |
| LM358ADGKRG4 | ACTIVE | VSSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (M6L, M6P, M6S, M6U) | Samples |
| LM358ADR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU \| SN | Level-1-260C-UNLIM | 0 to 70 | LM358A | Samples |
| LM358ADRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | LM358A | Samples |
| LM358ADRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | LM358A | Samples |
| LM358AP | ACTIVE | PDIP | P | 8 | 50 | Green (RoHS & no Sb/Br) | NIPDAU \| SN | N / A for Pkg Type | 0 to 70 | LM358AP | Samples |
| LM358APE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | NIPDAU | N / A for Pkg Type | 0 to 70 | LM358AP | Samples |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LM358APW | ACTIVE | TSSOP | PW | 8 | 150 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | L358A | Samples |
| LM358APWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU \| SN | Level-1-260C-UNLIM | 0 to 70 | L358A | Samples |
| LM358APWRG4 | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | L358A | Samples |
| LM358BAIDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | L358BA | Samples |
| LM358BIDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | LM358B | Samples |
| LM358BIPWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | LM358B | Samples |
| LM358D | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | LM358 | Samples |
| LM358DG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | LM358 | Samples |
| LM358DGKR | ACTIVE | VSSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU \| NIPDAUAG | Level-1-260C-UNLIM | 0 to 70 | (M5L, M5P, M5S, M5U) | Samples |
| LM358DGKRG4 | ACTIVE | VSSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (M5L, M5P, M5S, M5U) | Samples |
| LM358DR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU \| SN | Level-1-260C-UNLIM | 0 to 70 | LM358 | Samples |
| LM358DRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | LM358 | Samples |
| LM358DRG3 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | SN | Level-1-260C-UNLIM | 0 to 70 | LM358 | Samples |
| LM358DRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | LM358 | Samples |
| LM358P | ACTIVE | PDIP | P | 8 | 50 | Green (RoHS & no Sb/Br) | NIPDAU \| SN | N / A for Pkg Type | 0 to 70 | LM358P | Samples |
| LM358PE3 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | SN | N / A for Pkg Type | 0 to 70 | LM358P | Samples |
| LM358PE4 | ACTIVE | PDIP | P | 8 | 50 | Green (RoHS & no Sb/Br) | NIPDAU | N / A for Pkg Type | 0 to 70 | LM358P | Samples |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LM358PSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | L358 | Samples |
| LM358PW | ACTIVE | TSSOP | PW | 8 | 150 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | L358 | Samples |
| LM358PWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU \| SN | Level-1-260C-UNLIM | 0 to 70 | L358 | Samples |
| LM358PWRG3 | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | SN | Level-1-260C-UNLIM | 0 to 70 | L358 | Samples |
| LM358PWRG4 | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | L358 | Samples |
| LM358PWRG4-JF | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | L358 | Samples |
| PLM2904BIPWR | ACTIVE | TSSOP | PW | 8 | 2000 | TBD | Call TI | Call TI | -40 to 125 | | Samples |
| PLM358BIPWR | ACTIVE | TSSOP | PW | 8 | 2000 | TBD | Call TI | Call TI | -40 to 85 | | 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.



**OTHER QUALIFIED VERSIONS OF LM258A, LM2904, LM2904B :**

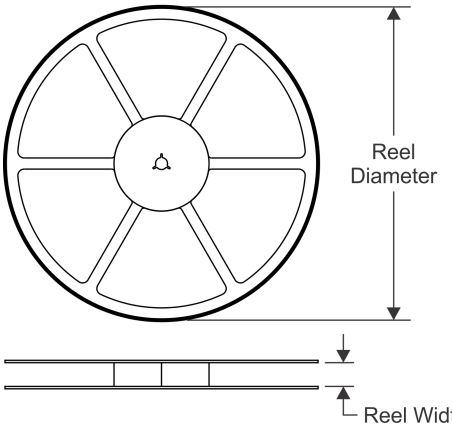
- Automotive: LM2904-Q1, LM2904B-Q1
- Enhanced Product: LM258A-EP, LM2904-EP

NOTE: Qualified Version Definitions:

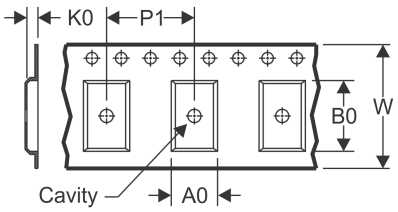
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

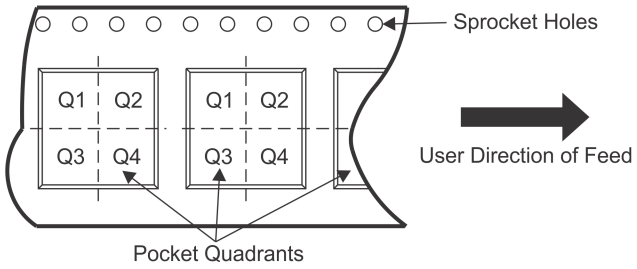



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

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



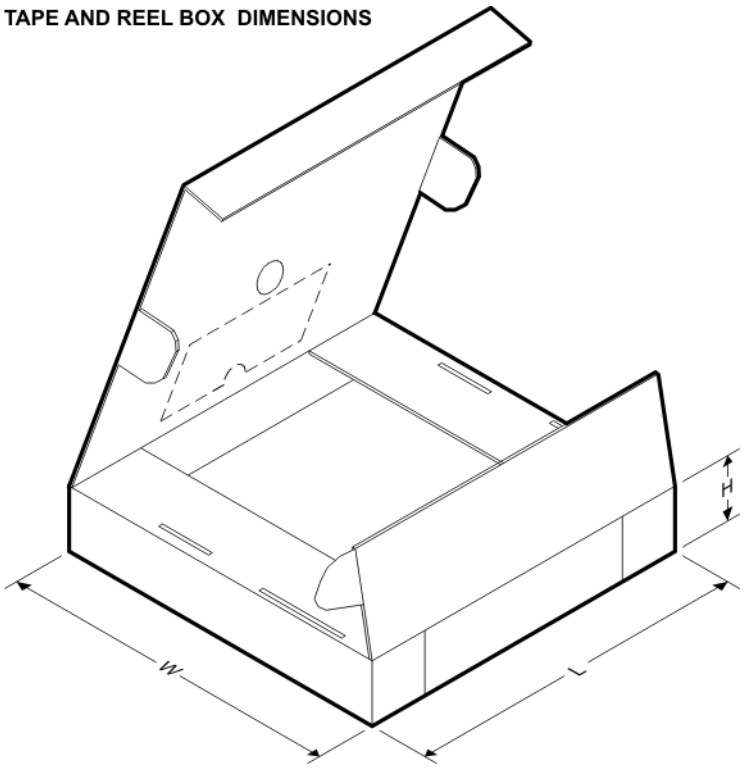

*All dimensions are nominal

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LM258ADGKR | VSSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| LM258ADR | SOIC | D | 8 | 2500 | 330.0 | 15.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM258ADR | SOIC | D | 8 | 2500 | 330.0 | 12.8 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM258ADR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM258ADR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM258ADRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM258ADRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM258DGKR | VSSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| LM258DR | SOIC | D | 8 | 2500 | 330.0 | 15.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM258DR | SOIC | D | 8 | 2500 | 330.0 | 12.8 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM258DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM258DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM258DRG3 | SOIC | D | 8 | 2500 | 330.0 | 12.8 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM258DRG3 | SOIC | D | 8 | 2500 | 330.0 | 15.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM258DRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM258DRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904AVQDR | SOIC | D | 8 | 2500 | 330.0 | 12.5 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904AVQDRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.5 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LM2904AVQPWR | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM2904AVQPWRG4 | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM2904BAIDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904BIDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904BIPWR | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM2904DGKR | VSSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| LM2904DGKR | VSSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| LM2904DR | SOIC | D | 8 | 2500 | 330.0 | 15.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904DR | SOIC | D | 8 | 2500 | 330.0 | 12.8 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904DRG3 | SOIC | D | 8 | 2500 | 330.0 | 15.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904DRG3 | SOIC | D | 8 | 2500 | 330.0 | 12.8 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904DRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904DRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904PWR | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM2904PWR | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM2904PWRG3 | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM2904PWRG4-JF | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM2904QDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904VQDR | SOIC | D | 8 | 2500 | 330.0 | 12.5 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM2904VQPWR | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM2904VQPWRG4 | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM358ADGKR | VSSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| LM358ADR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358ADR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358ADR | SOIC | D | 8 | 2500 | 330.0 | 15.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358ADR | SOIC | D | 8 | 2500 | 330.0 | 12.8 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358ADRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358ADRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358APWR | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM358APWR | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM358APWRG4 | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM358BAIDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358BIDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358BIPWR | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM358DGKR | VSSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| LM358DGKR | VSSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| LM358DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358DR | SOIC | D | 8 | 2500 | 330.0 | 12.8 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358DR | SOIC | D | 8 | 2500 | 330.0 | 15.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358DRG3 | SOIC | D | 8 | 2500 | 330.0 | 12.8 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LM358DRG3 | SOIC | D | 8 | 2500 | 330.0 | 15.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358DRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358DRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LM358PWR | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM358PWR | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM358PWRG3 | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM358PWRG4 | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM358PWRG4-JF | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |

**TAPE AND REEL BOX DIMENSIONS**




*All dimensions are nominal

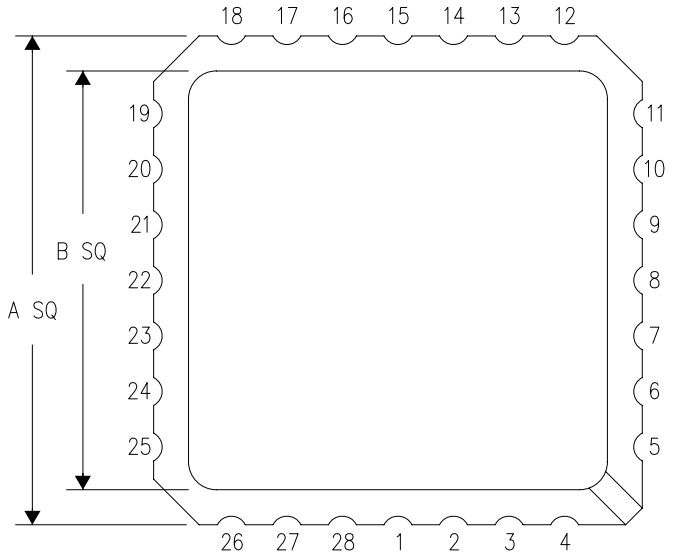
| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| LM258ADGKR | VSSOP | DGK | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| LM258ADR | SOIC | D | 8 | 2500 | 333.2 | 345.9 | 28.6 |
| LM258ADR | SOIC | D | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| LM258ADR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM258ADR | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM258ADRG4 | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM258ADRG4 | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM258DGKR | VSSOP | DGK | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| LM258DR | SOIC | D | 8 | 2500 | 333.2 | 345.9 | 28.6 |

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| LM258DR | SOIC | D | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| LM258DR | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM258DR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM258DRG3 | SOIC | D | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| LM258DRG3 | SOIC | D | 8 | 2500 | 333.2 | 345.9 | 28.6 |
| LM258DRG4 | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM258DRG4 | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM2904AVQDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM2904AVQDRG4 | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM2904AVQPWR | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| LM2904AVQPWRG4 | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| LM2904BAIDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM2904BIDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM2904BIPWR | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| LM2904DGKR | VSSOP | DGK | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| LM2904DGKR | VSSOP | DGK | 8 | 2500 | 358.0 | 335.0 | 35.0 |
| LM2904DR | SOIC | D | 8 | 2500 | 333.2 | 345.9 | 28.6 |
| LM2904DR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM2904DR | SOIC | D | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| LM2904DR | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM2904DRG3 | SOIC | D | 8 | 2500 | 333.2 | 345.9 | 28.6 |
| LM2904DRG3 | SOIC | D | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| LM2904DRG4 | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM2904DRG4 | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM2904PWR | TSSOP | PW | 8 | 2000 | 364.0 | 364.0 | 27.0 |
| LM2904PWR | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| LM2904PWRG3 | TSSOP | PW | 8 | 2000 | 364.0 | 364.0 | 27.0 |
| LM2904PWRG4-JF | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| LM2904QDR | SOIC | D | 8 | 2500 | 350.0 | 350.0 | 43.0 |
| LM2904VQDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM2904VQPWR | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| LM2904VQPWRG4 | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| LM358ADGKR | VSSOP | DGK | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| LM358ADR | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM358ADR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM358ADR | SOIC | D | 8 | 2500 | 333.2 | 345.9 | 28.6 |
| LM358ADR | SOIC | D | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| LM358ADRG4 | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM358ADRG4 | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM358APWR | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| LM358APWR | TSSOP | PW | 8 | 2000 | 364.0 | 364.0 | 27.0 |
| LM358APWRG4 | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| LM358BAIDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM358BIDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |

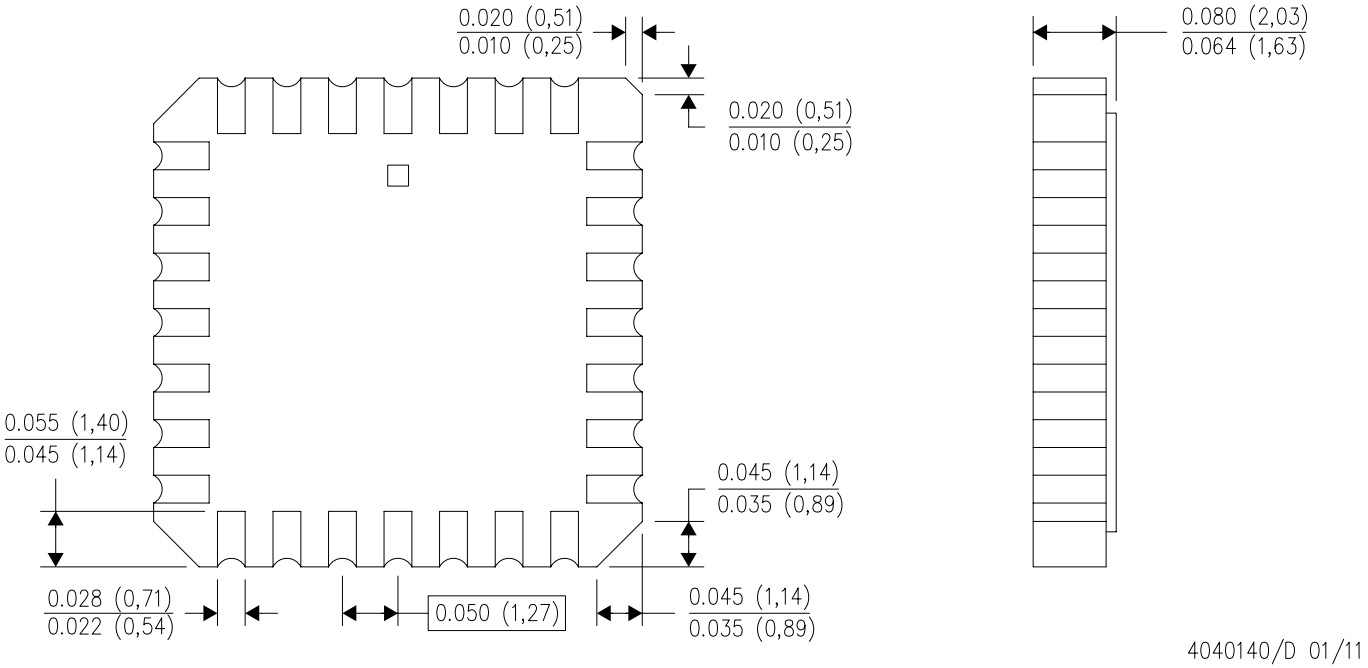
| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| LM358BIPWR | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| LM358DGKR | VSSOP | DGK | 8 | 2500 | 358.0 | 335.0 | 35.0 |
| LM358DGKR | VSSOP | DGK | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| LM358DR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM358DR | SOIC | D | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| LM358DR | SOIC | D | 8 | 2500 | 333.2 | 345.9 | 28.6 |
| LM358DR | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM358DRG3 | SOIC | D | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| LM358DRG3 | SOIC | D | 8 | 2500 | 333.2 | 345.9 | 28.6 |
| LM358DRG4 | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| LM358DRG4 | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LM358PWR | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| LM358PWR | TSSOP | PW | 8 | 2000 | 364.0 | 364.0 | 27.0 |
| LM358PWRG3 | TSSOP | PW | 8 | 2000 | 364.0 | 364.0 | 27.0 |
| LM358PWRG4 | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |
| LM358PWRG4-JF | TSSOP | PW | 8 | 2000 | 367.0 | 367.0 | 35.0 |

FK (S–CQCC–N**) LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN

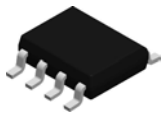



| NO. OF TERMINALS ** | A | | B | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| 20 | 0.342 (8,69) | 0.358 (9,09) | 0.307 (7,80) | 0.358 (9,09) |
| 28 | 0.442 (11,23) | 0.458 (11,63) | 0.406 (10,31) | 0.458 (11,63) |
| 44 | 0.640 (16,26) | 0.660 (16,76) | 0.495 (12,58) | 0.560 (14,22) |
| 52 | 0.740 (18,78) | 0.761 (19,32) | 0.495 (12,58) | 0.560 (14,22) |
| 68 | 0.938 (23,83) | 0.962 (24,43) | 0.850 (21,6) | 0.858 (21,8) |
| 84 | 1.141 (28,99) | 1.165 (29,59) | 1.047 (26,6) | 1.063 (27,0) |




4040140/D 01/11

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a metal lid.
D. Falls within JEDEC MS–004

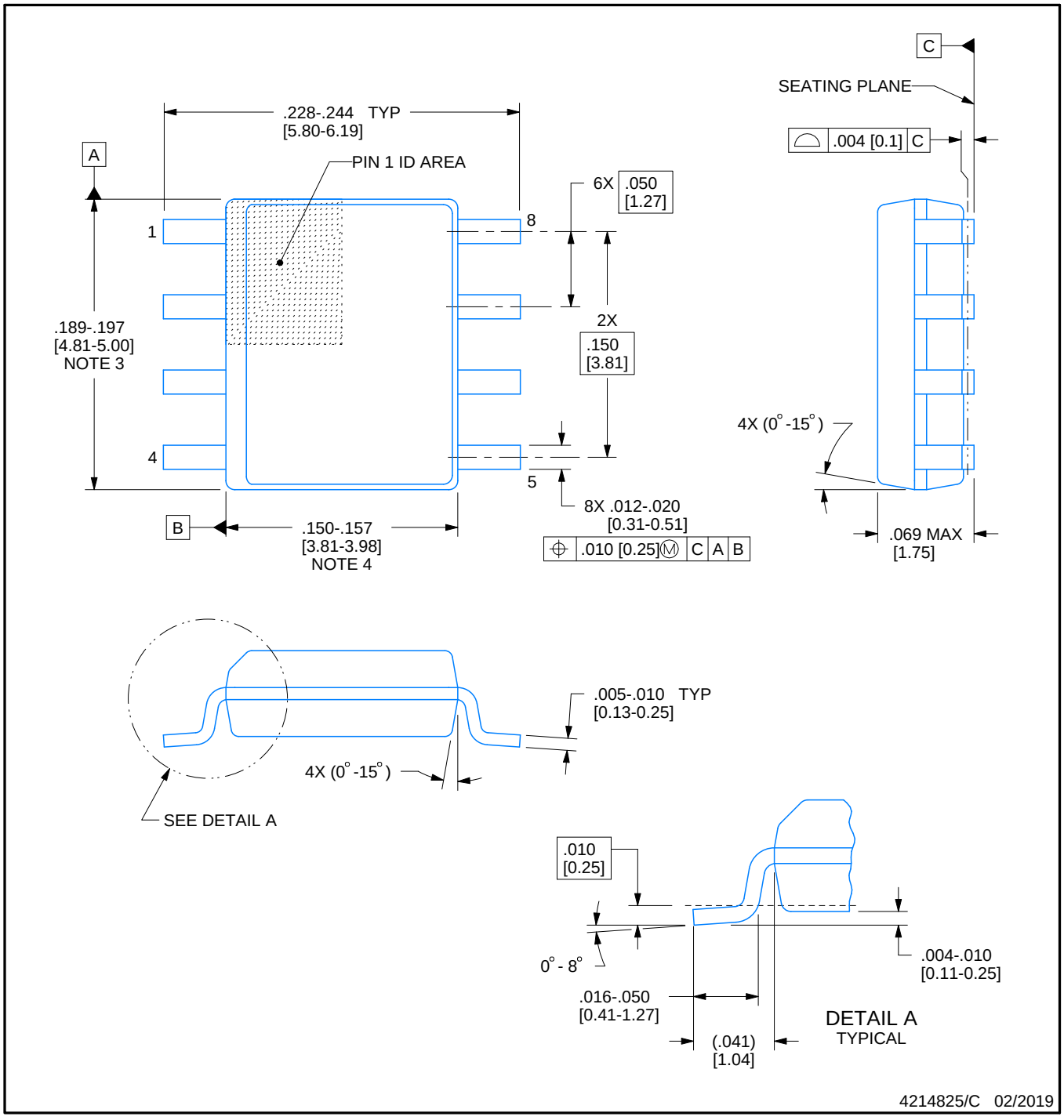


# PACKAGE OUTLINE

## D0008A

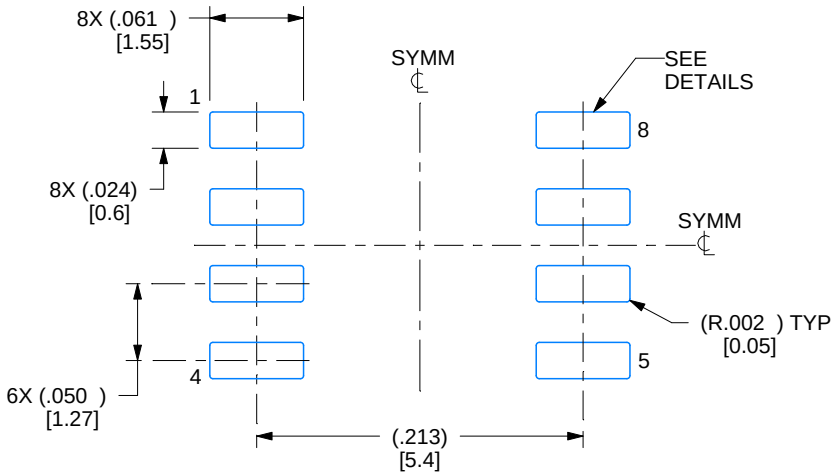
## SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

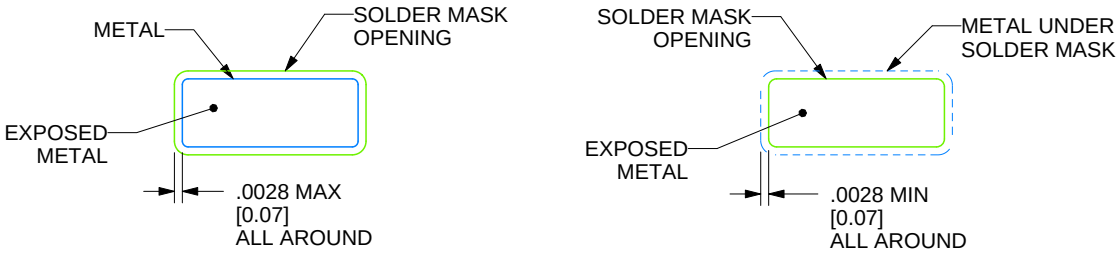



NOTES:

1. 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.
2. This drawing is subject to change without notice.
3. 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.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X




SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

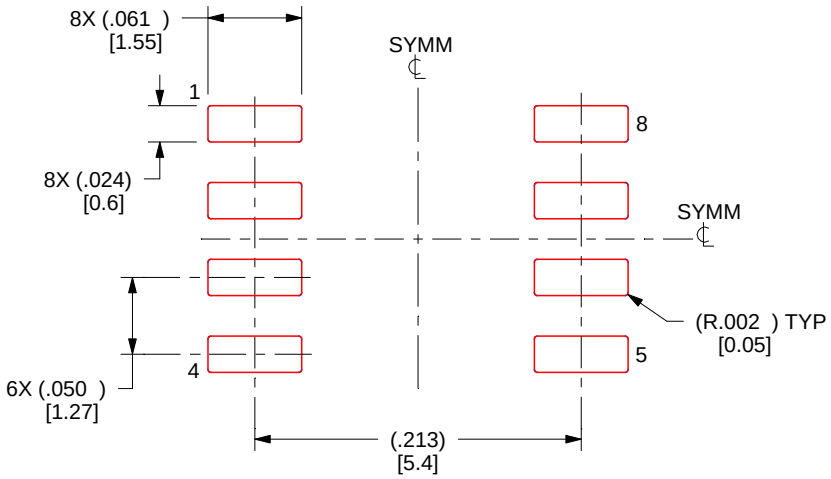
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# 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

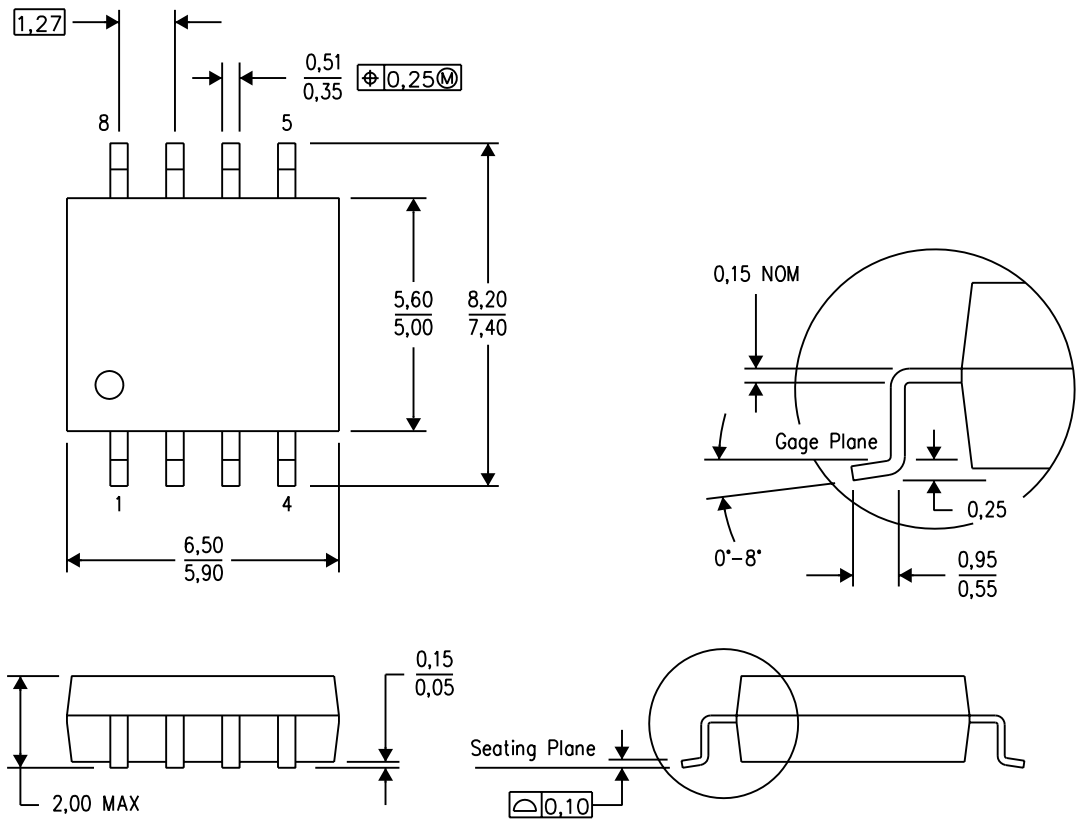
4214825/C 02/2019

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.

## MECHANICAL DATA

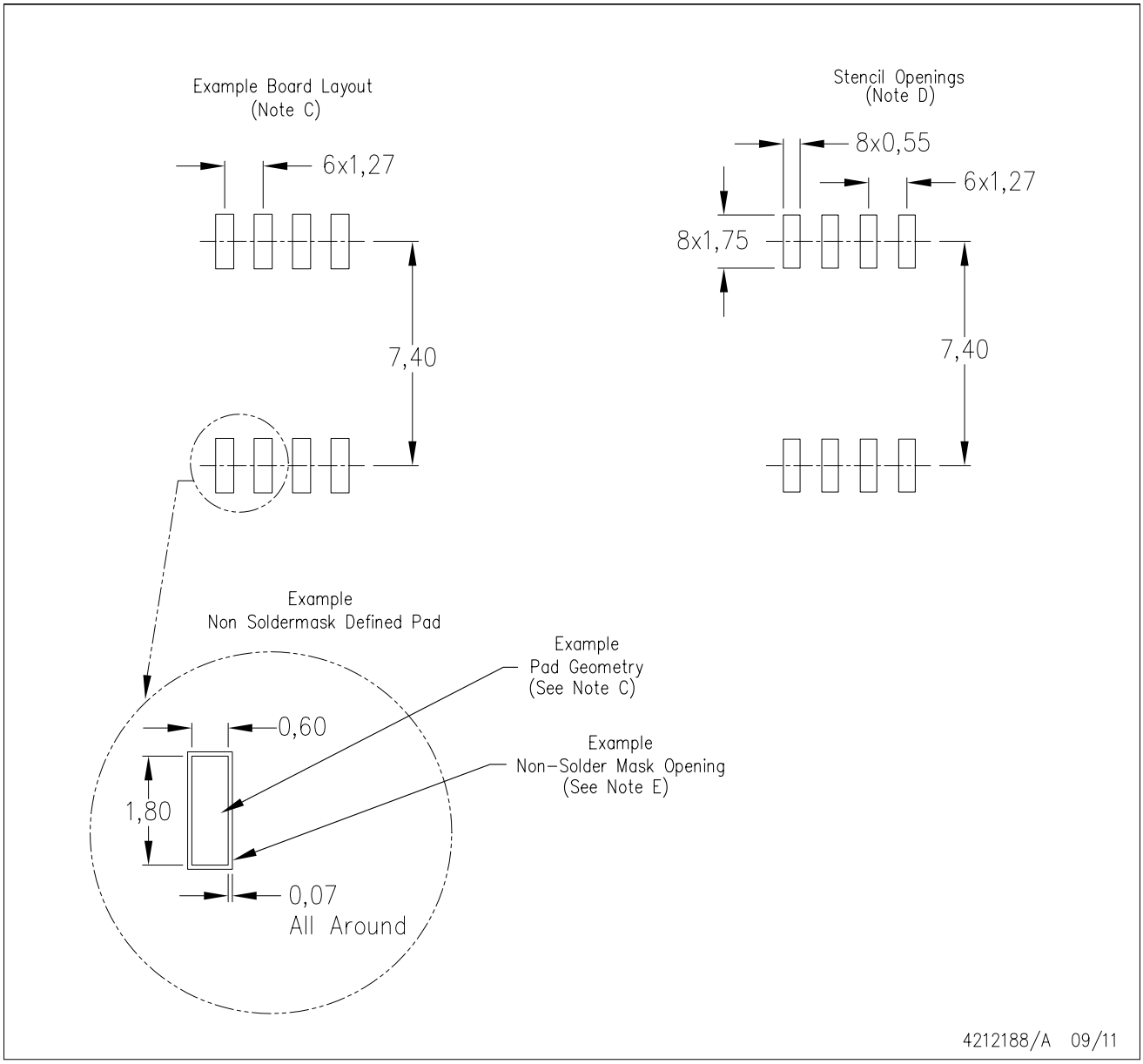
**PS (R-PDSO-G8)** **PLASTIC SMALL-OUTLINE PACKAGE**




4040063/C 03/03

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

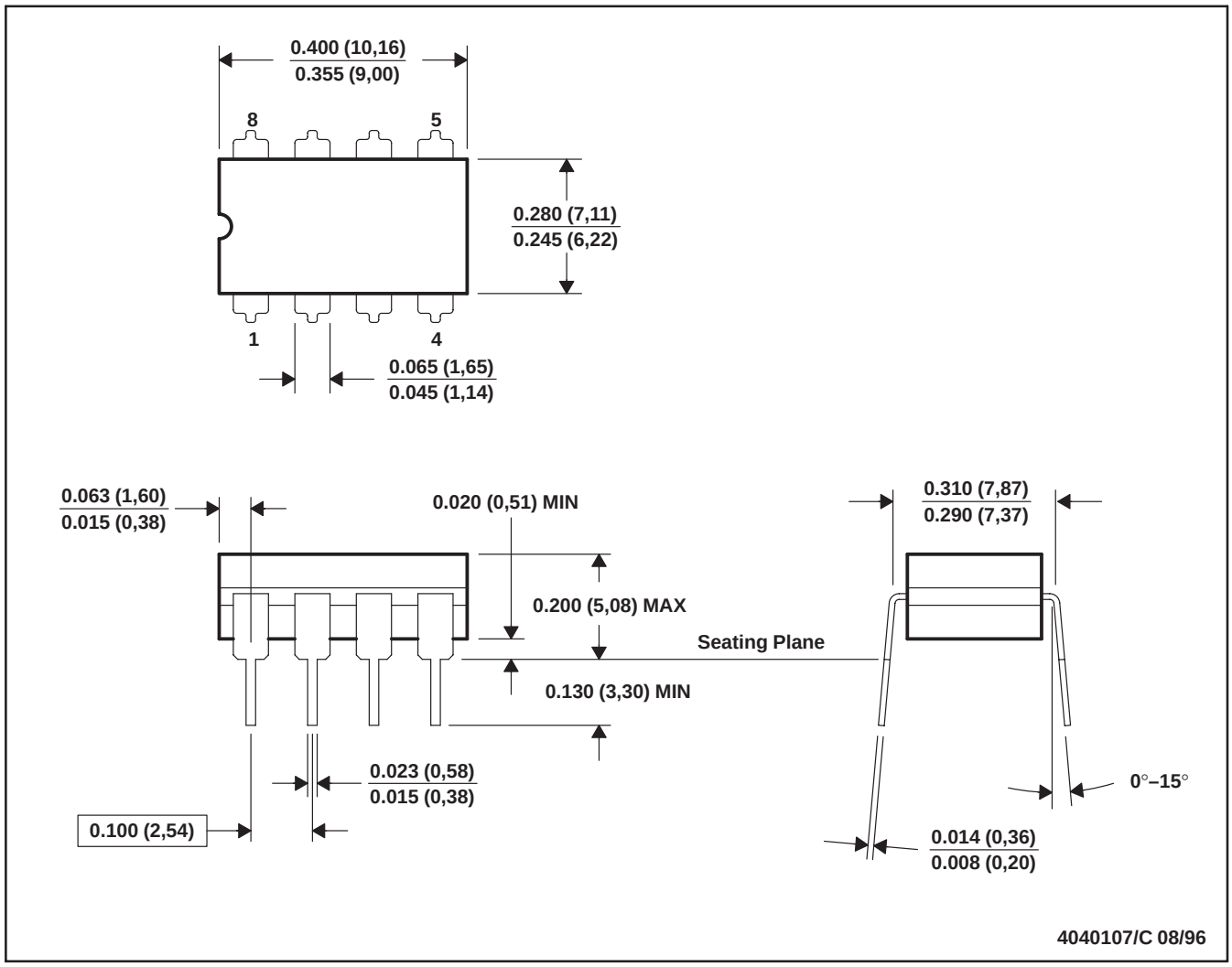
PS (R–PDSO–G8) PLASTIC SMALL OUTLINE




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.

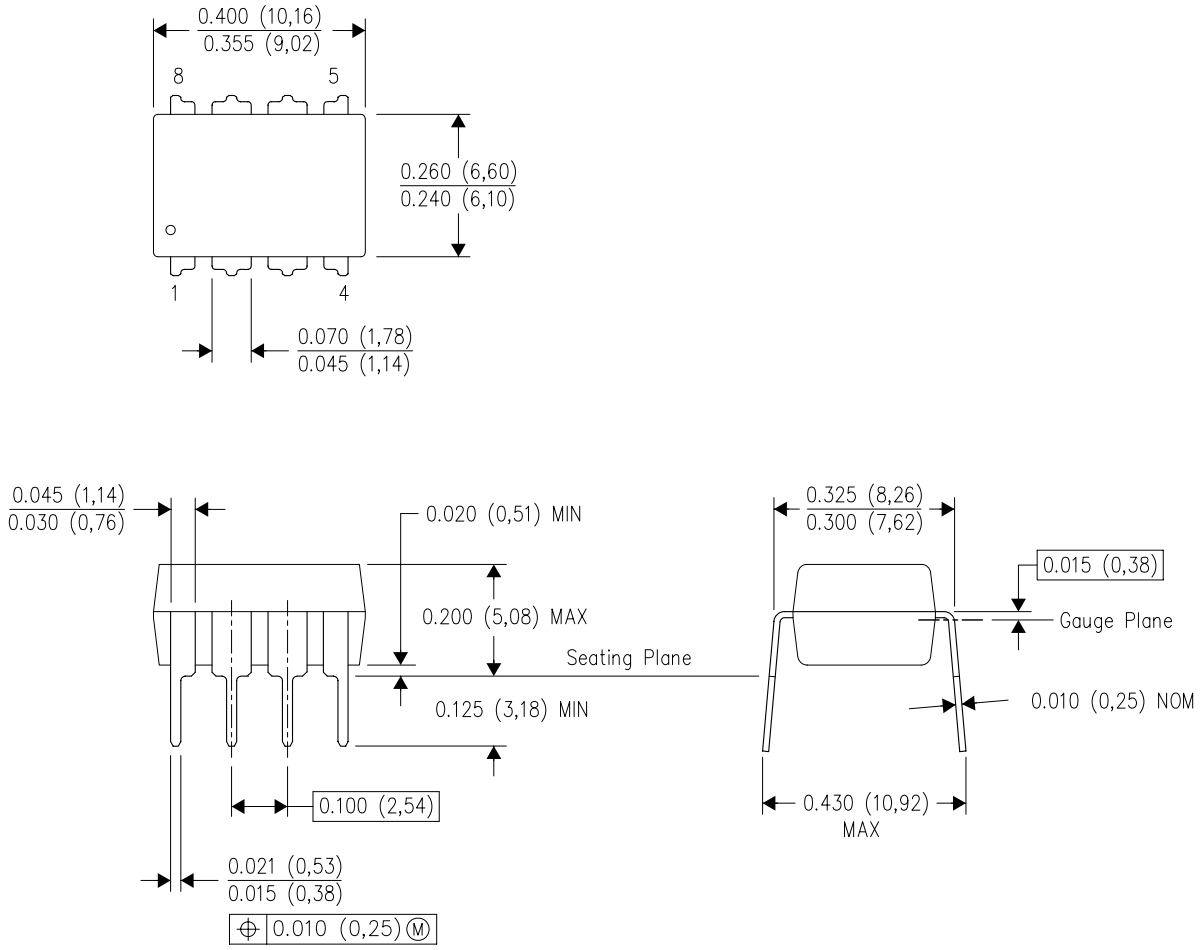
MCER001A – JANUARY 1995 – REVISED JANUARY 1997

**JG (R-GDIP-T8)** **CERAMIC DUAL-IN-LINE**



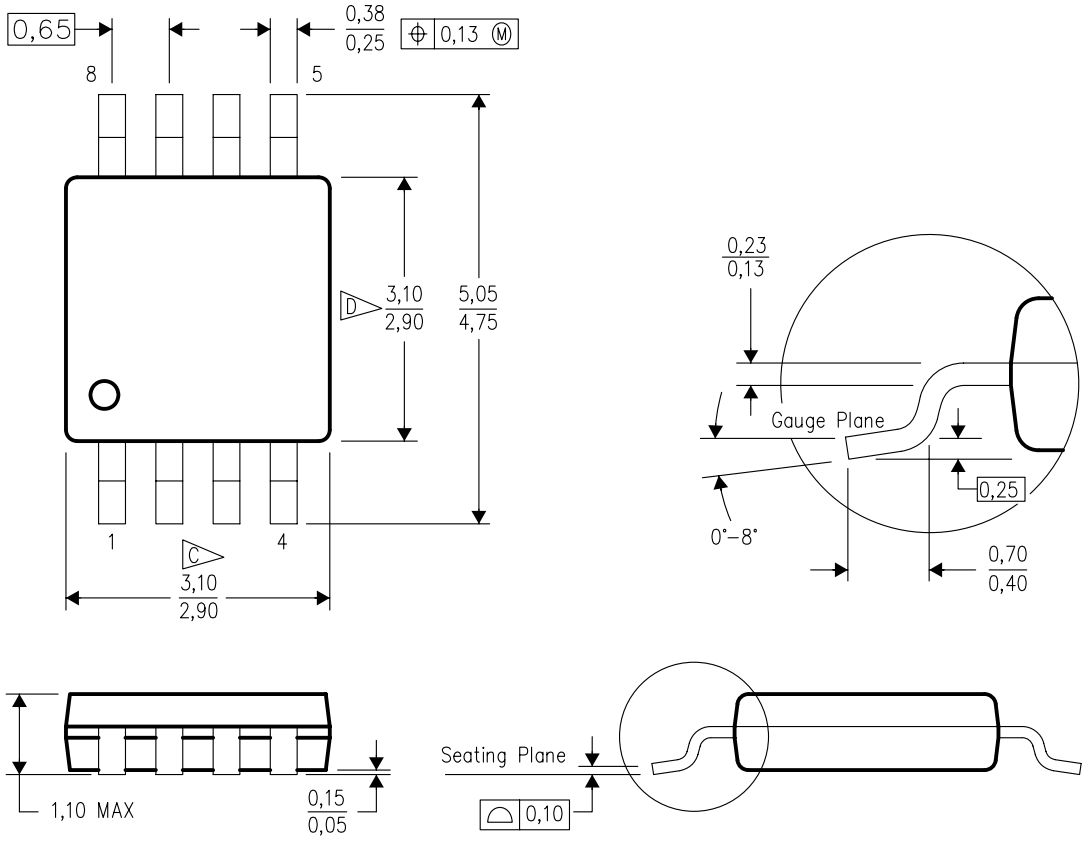

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification.
E. Falls within MIL STD 1835 GDIP1-T8

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.

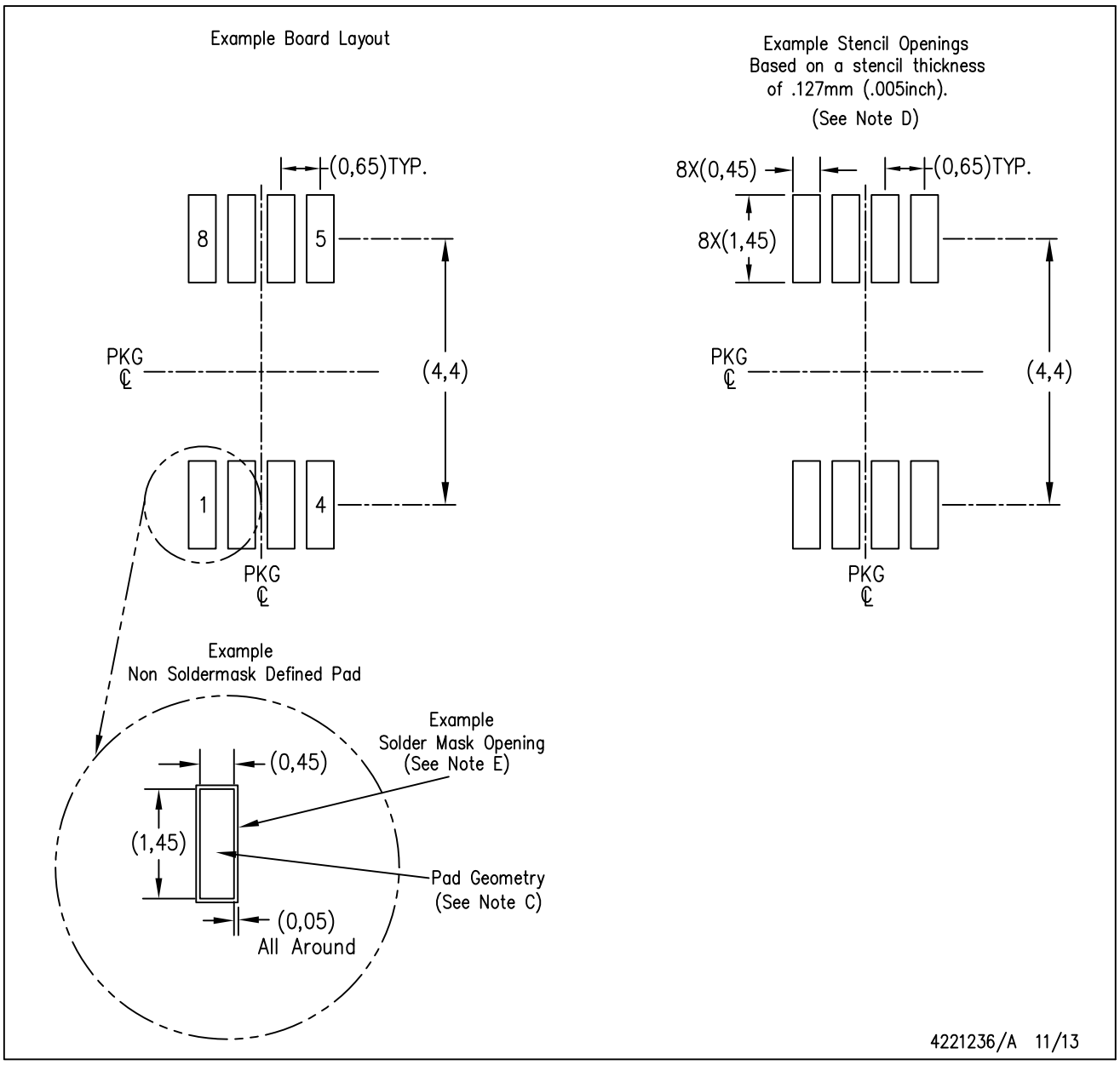
## DGK (S–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE




4073329/E 05/06

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.

# DGK (S–PDSO–G8) PLASTIC SMALL OUTLINE PACKAGE



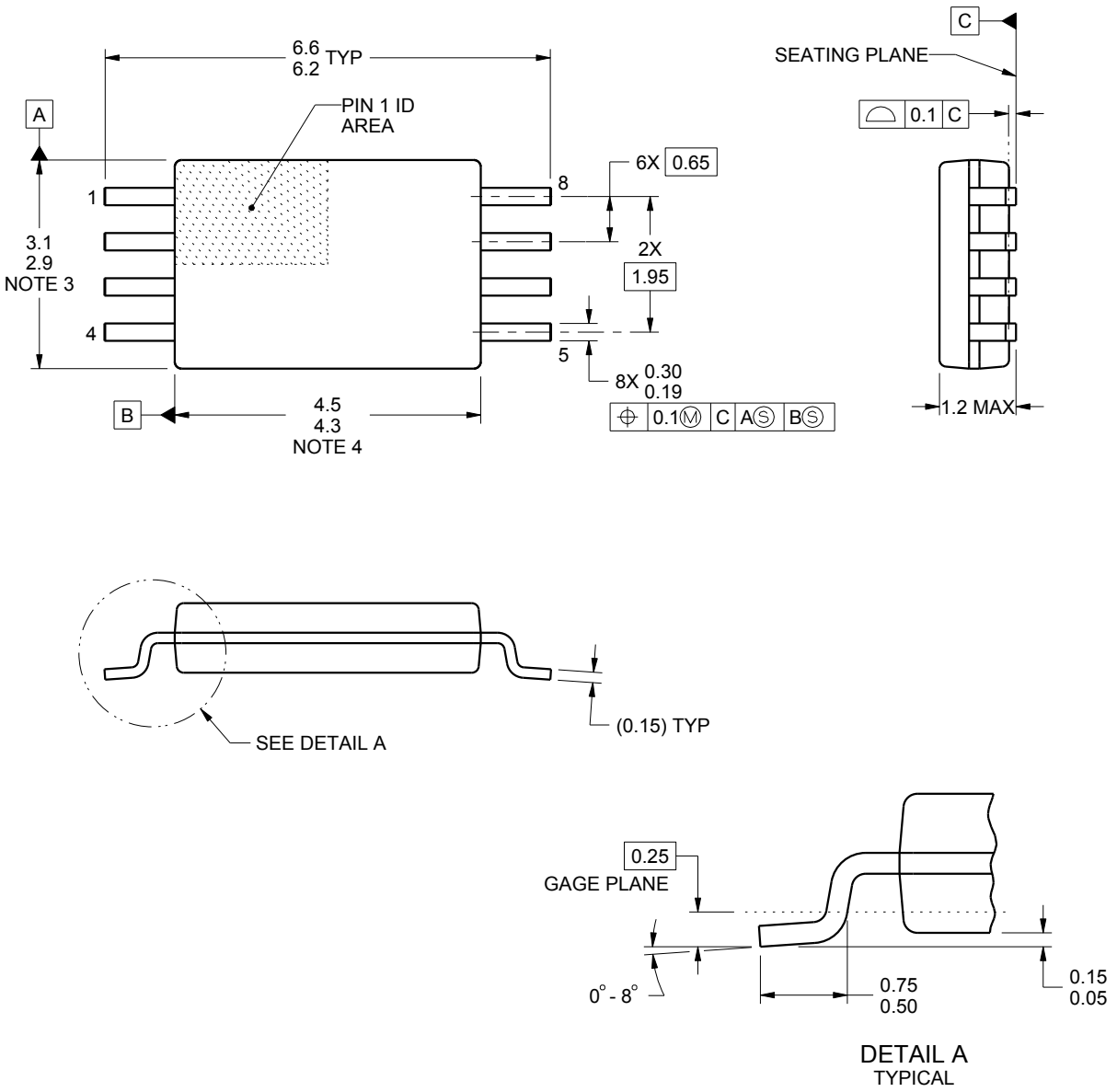

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact 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.

# PACKAGE OUTLINE

## PW0008A

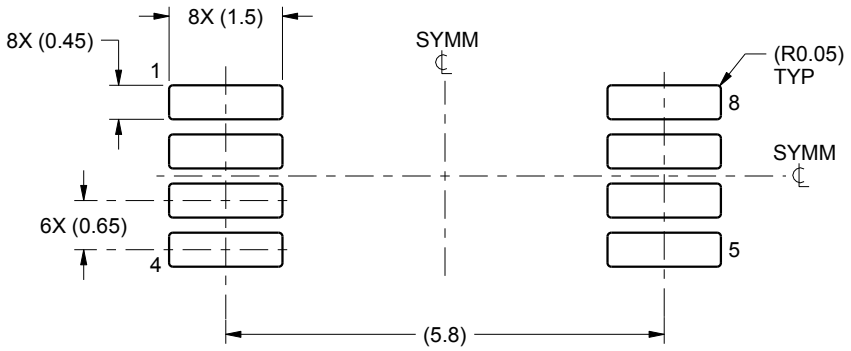
## TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

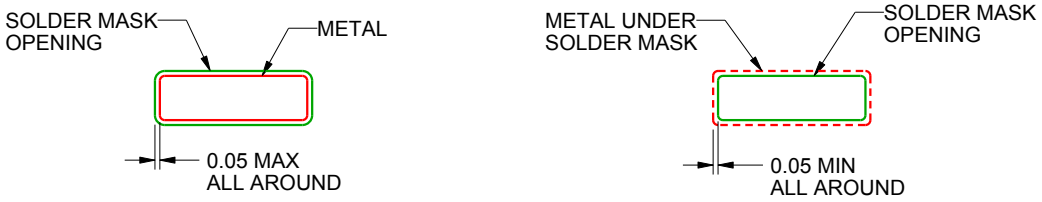



NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153, variation AA.




LAND PATTERN EXAMPLE
SCALE:10X

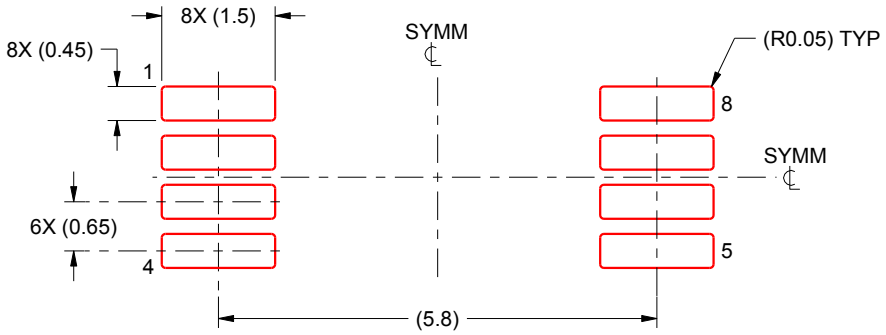



SOLDER MASK DETAILS
NOT TO SCALE

4221848/A 02/2015

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.




SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:10X

4221848/A 02/2015

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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