



TL07xx Low-Noise JFET-Input Operational Amplifiers

1 Features

- Low Power Consumption
- Wide Common-Mode and Differential Voltage Ranges
- Low Input Bias and Offset Currents
- Output Short-Circuit Protection
- Low Total Harmonic Distortion: 0.003% Typical
- Low Noise
 $V_n = 18 \text{ nV}/\sqrt{\text{Hz}}$ Typ at $f = 1 \text{ kHz}$
- High-Input Impedance: JFET Input Stage
- Internal Frequency Compensation
- Latch-Up-Free Operation
- High Slew Rate: $13 \text{ V}/\mu\text{s}$ Typical
- Common-Mode Input Voltage Range
Includes V_{CC+}

2 Applications

- Motor Integrated Systems: UPS
- Drives and Control Solutions: AC Inverter and VF Drives
- Renewables: Solar Inverters
- Pro Audio Mixers
- DLP Front Projection System
- Oscilloscopes

3 Description

The TL07xx JFET-input operational amplifier family is designed to offer a wider selection than any previously developed operational amplifier family. Each of these JFET-input operational amplifiers incorporates well-matched, high-voltage JFET and bipolar transistors in a monolithic integrated circuit.

The devices feature high slew rates, low-input bias and offset currents, and low offset-voltage temperature coefficient. The low harmonic distortion and low noise make the TL07xseries ideally suited for high-fidelity and audio pre-amplifier applications. Offset adjustment and external compensation options are available within the TL07x family.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TL07xxD	SOIC (14)	8.65 mm × 3.91 mm
	SOIC (8)	4.90 mm × 3.90 mm
TL07xxFK	LCCC (20)	8.89 mm × 8.89 mm
TL07xxJG	PDIP (8)	9.59 mm × 6.67 mm
TL074xJ	CDIP (14)	19.56 mm × 6.92 mm
TL07xxP	PDIP (8)	9.59 mm × 6.35 mm
TL07xxPS	SO (8)	6.20 mm × 5.30 mm
TL074xN	PDIP (14)	19.3 mm × 6.35 mm
TL074xNS	SO (14)	10.30 mm × 5.30 mm
TL07xxPW	TSSOP (8)	4.40 mm × 3.00 mm
TL074xPW	TSSOP (14)	5.00 mm × 4.40 mm

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

Logic Symbols

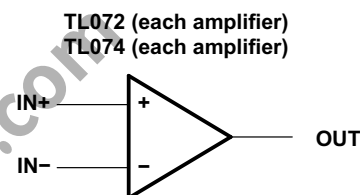
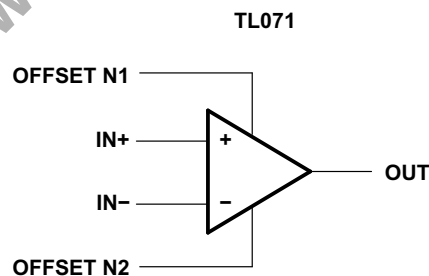


Table of Contents

1 Features	1	8.3 Feature Description	14
2 Applications	1	8.4 Device Functional Modes	14
3 Description	1	9 Application and Implementation	15
4 Revision History	2	9.1 Application Information	15
5 Pin Configuration and Functions	3	9.2 Typical Application	15
6 Specifications	5	9.3 System Examples	16
6.1 Absolute Maximum Ratings	5	10 Power Supply Recommendations	17
6.2 ESD Ratings	5	11 Layout	17
6.3 Recommended Operating Conditions	5	11.1 Layout Guidelines	17
6.4 Thermal Information	5	11.2 Layout Example	18
6.5 Electrical Characteristics, TL07xC, TL07xAC, TL07xBC, TL07xI	6	12 Device and Documentation Support	19
6.6 Electrical Characteristics, TL07xM	7	12.1 Documentation Support	19
6.7 Switching Characteristics	7	12.2 Related Links	19
6.8 Typical Characteristics	8	12.3 Community Resources	19
7 Parameter Measurement Information	12	12.4 Trademarks	19
8 Detailed Description	13	12.5 Electrostatic Discharge Caution	19
8.1 Overview	13	12.6 Glossary	19
8.2 Functional Block Diagram	13	13 Mechanical, Packaging, and Orderable Information	19

4 Revision History

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

Changes from Revision L (February 2014) to Revision M

Page

- Added *Device Information* table, *Pin Configuration and Functions* section, *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section **1**
- Moved *Typical Characteristics* into *Specifications* section. **8**

Changes from Revision K (January 2014) to Revision L

Page

- Moved T_{stg} to *Handling Ratings* table **5**
- Added missing *Electric Characteristics* table **6**
- Added *Device and Documentation Support* section **19**
- Added *Mechanical, Packaging, and Orderable Information* section **19**

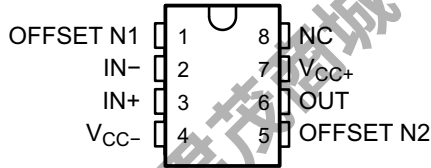
Changes from Revision J (March 2005) to Revision K

Page

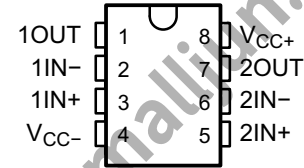
- Updated document to new TI datasheet format - no specification changes. **1**
- Added ESD warning **19**

5 Pin Configuration and Functions

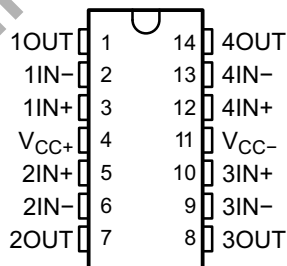
TL071x D, P, and PS Package
8-Pin SOIC, PDIP, SO
Top View



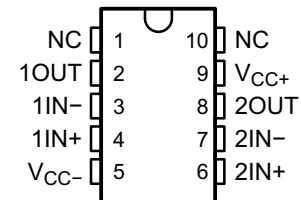
TL072x D, JG, P, PS and PW Package
8-Pin SOIC, CDIP, PDIP, SO
Top View



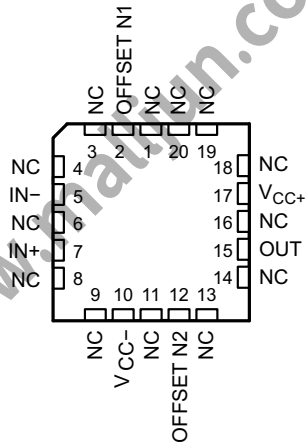
TL074x D, J, N, NS, PW, and W Package
14-Pin SOIC, CDIP, PDIP, SO and CFP
Top View



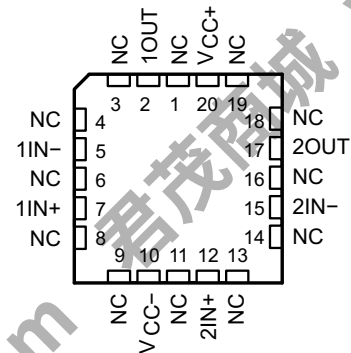
TL072 U Package
10-Pin CFP
Top View



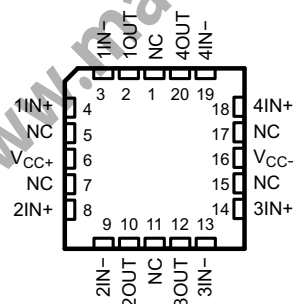
TL071 FK Package
20-Pin LCCC
Top View



TL072 FK Package
20-Pin LCCC
Top View



TL074 FK Package
20-Pin LCCC
Top View



Pin Functions

PIN								I/O	DESCRIPTION	
NAME	TL071		TL072			TL074				
	SOIC, PDIP, SO	LCCC	SOIC, CDIP, PDIP, SO	CFP	LCCC	SOIC, CDIP, PDIP, SO, CFP	LCCC			
1IN–	—	—	2	3	5	2	3	I	Inverting input	
1IN+	—	—	3	4	7	3	4	I	Non-Inverting input	
1OUT	—	—	1	2	2	1	2	O	Output	
2IN–	—	—	6	7	15	6	9	I	Inverting input	
2IN+	—	—	5	6	12	5	8	I	Non-Inverting input	
2OUT	—	—	7	8	17	7	10	O	Output	
3IN–	—	—	—	—	—	9	13	I	Inverting input	
3IN+	—	—	—	—	—	10	14	I	Non-Inverting input	
3OUT	—	—	—	—	—	8	12	O	Output	
4IN–	—	—	—	—	—	13	19	I	Inverting input	
4IN+	—	—	—	—	—	12	18	I	Non-Inverting input	
4OUT	—	—	—	—	—	14	20	O	Output	
IN–	2	5	—	—	—	—	—	I	Inverting input	
IN+	3	7	—	—	—	—	—	I	Non-Inverting input	
NC ⁽¹⁾	8	1	1	1	1	—	1	—	Do not connect	
		3								—
		4								—
		6								—
		8								—
		9								9
		11	0	—	11	5				
		13			13	7				
		14			14	11				
		16			16	15				
		18			18	17				
		19			19					
		20			—					
OFFSET N1	1	2	—	—	—	—	—	—	Input offset adjustment	
OFFSET N2	5	12	—	—	—	—	—	—	Input offset adjustment	
OUT	6	15	—	—	—	—	—	O	Output	
V _{CC} –	4	10	4	5	10	11	16	—	Power supply	
V _{CC} +	7	17	8	9	20	4	6	—	Power supply	

(1) NC – No internal connection

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) ⁽¹⁾

		MIN	MAX	UNIT
$V_{CC+} - V_{CC-}$	Supply voltage ⁽²⁾	–18	18	V
V_{ID}	Differential input voltage ⁽³⁾	–30	30	V
V_I	Input voltage ⁽²⁾⁽⁴⁾	–15	15	V
	Duration of output short circuit ⁽⁵⁾	Unlimited		
T_J	Operating Virtual Junction Temperature		150	°C
	Case temperature for 60 seconds - FK package		260	°C
	Lead temperature 1.8 mm (1/16 inch) from case for 10 seconds		300	°C
T_{stg}	Storage temperature	–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+} and V_{CC-} .

(3) Differential voltages are at $IN+$, with respect to $IN-$.

(4) The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 V, whichever is less.

(5) The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

6.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±2000
		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.

6.3 Recommended Operating Conditions

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

		MIN	MAX	UNIT
V_{CC+}	Supply voltage	5	15	V
V_{CC-}	Supply voltage	–5	–15	V
V_{CM}	Common-mode voltage	$V_{CC-} + 4$	$V_{CC+} - 4$	V
T_A	Operating free-air temperature	TL07xM	–55	125
		TL08xQ	–40	125
		TL07xI	–40	85
		TL07xA, TL07xB, TL07xC	0	70

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TL071/TL072/TL074										UNIT	
		D (SOIC)		FK (LCCC)	J (CDIP)		N (PDIP)		NS (SO)		PW (TSSOP)		
		8 PINS	14 PINS	20 PINS	8 PINS	14 PINS	8 PINS	14 PINS	8 PINS	14 PINS	8 PINS		14 PINS
R _{θJA}	Junction-to-ambient thermal resistance	97	86	—	—	—	85	80	95	76	150	113	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	—	—	5.61	15.05	14.5	—	—	—	—	—	—	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, [SPRA953](#).

6.5 Electrical Characteristics, TL07xC, TL07xAC, TL07xBC, TL07xI

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

PARAMETER		TEST CONDITIONS ⁽¹⁾		T _A ⁽²⁾	TL071C, TL072C, TL074C			TL071AC, TL072AC, TL074AC			TL071BC, TL072BC, TL074BC			TL071I, TL072I, TL074I			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _O = 0, R _S = 50 Ω	25°C	3		10	3		6	2		3	3		6	mV	
		Full range				13			7.5			5			8		
αV _{IO}	Temperature coefficient of input offset voltage	V _O = 0, R _S = 50 Ω	Full range	18			18			18			18			μV/°C	
I _{IO}	Input offset current	V _O = 0	25°C	5		100	5		100	5		100	5		100	pA	
			Full range			10			2			2			2	nA	
I _{IB}	Input bias current ⁽³⁾	V _O = 0	25°C	65		200	65		200	65		200	65		200	pA	
			Full range			7			7			7			7	nA	
V _{ICR}	Common-mode input voltage range		25°C	±11	-12 to 15		±11	-12 to 15		±11	-12 to 15		±11	-12 to 15		V	
V _{OM}	Maximum peak output voltage swing	R _L = 10 kΩ	25°C	±12	±13.5		±12	±13.5		±12	±13.5		±12	±13.5		V	
		R _L ≥ 10 kΩ		±12			±12			±12			±12				
		R _L ≥ 2 kΩ	Full range	±10			±10			±10			±10				
A _{VD}	Large-signal differential voltage amplification	V _O = ±10 V, R _L ≥ 2 kΩ	25°C	25	200		50	200		50	200		50	200		V/mV	
			Full range	15			25			25			25				
B ₁	Utility-gain bandwidth		25°C	3			3			3			3			MHz	
r _i	Input resistance		25°C	10 ¹²			10 ¹²			10 ¹²			10 ¹²			Ω	
CMRR	Common-mode rejection ratio	V _{IC} = V _{ICRmin} , V _O = 0, R _S = 50 Ω	25°C	70	100		75	100		75	100		75	100		dB	
k _{SVR}	Supply-voltage rejection ratio (ΔV _{CC} /ΔV _{IO})	V _{CC} = ±9 V to ±15 V, V _O = 0, R _S = 50 Ω	25°C	70	100		80	100		80	100		80	100		dB	
I _{CC}	Supply current (each amplifier)	V _O = 0, No load	25°C	1.4		2.5	1.4		2.5	1.4		2.5	1.4		2.5	mA	
V _{O1} /V _{O2}	Crosstalk attenuation	A _{VO} = 100	25°C	120			120			120			120			dB	

- (1) All characteristics are measured under open-loop conditions with zero common-mode voltage, unless otherwise specified.
- (2) Full range is $T_A = 0^\circ C$ to $70^\circ C$ for TL07_C, TL07_AC, TL07_BC and is $T_A = -40^\circ C$ to $85^\circ C$ for TL07_I.
- (3) Input bias currents of an FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive, as shown in Figure 1. Pulse techniques must be used that maintain the junction temperature as close to the ambient temperature as possible.

6.6 Electrical Characteristics, TL07xM

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

PARAMETER		TEST CONDITIONS ⁽¹⁾	T _A ⁽²⁾	TL071M, TL072M			TL074M			UNIT	
				MIN	TYP	MAX	MIN	TYP	MAX		
V _{IO}	Input offset voltage	V _O = 0, R _S = 50 Ω	25°C	3			6	3		9	mV
			Full range				9			15	
α _{VIO}	Temperature coefficient of input offset voltage	V _O = 0, R _S = 50 Ω	Full range	18				18			μV/°C
I _{IO}	Input offset current	V _O = 0	25°C	5			100	5		100	pA
			Full range				20			20	nA
I _{IB}	Input bias current	V _O = 0	25°C	65			200	65		200	pA
							50			20	nA
V _{ICR}	Common-mode input voltage range		25°C	±11	-12 to 15			±11	-12 to 15		V
V _{OM}	Maximum peak output voltage swing	R _L = 10 kΩ	25°C	±12	±13.5			±12	±13.5		V
		R _L ≥ 10 kΩ	Full range	±12			±12				
		R _L ≥ 2 kΩ		±10			±10				
A _{VD}	Large-signal differential voltage amplification	V _O = ±10 V, R _L ≥ 2 kΩ	25°C	35	200			35	200		V/mV
				15			15				
B ₁	Unity-gain bandwidth			3				3			MHz
r _i	Input resistance			10 ¹²				10 ¹²			Ω
CMRR	Common-mode rejection ratio	V _{IC} = V _{ICR} min, V _O = 0, R _S = 50 Ω	25°C	80	86			80	86		dB
k _{SVR}	Supply-voltage rejection ratio (ΔV _{CC±} /ΔV _{IO})	V _{CC} = ±9 V to ±15 V, V _O = 0, R _S = 50 Ω	25°C	80	86			80	86		dB
I _{CC}	Supply current (each amplifier)	V _O = 0, No load	25°C	1.4			2.5	1.4		2.5	mA
V _{O1} /V _{O2}	Crosstalk attenuation	A _{VD} = 100	25°C	120				120			dB

- Input bias currents of an FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive, as shown in Figure 1. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as possible.
- All characteristics are measured under open-loop conditions with zero common-mode voltage, unless otherwise specified. Full range is $T_A = -55^\circ\text{C}$ to 125°C .

6.7 Switching Characteristics

 $V_{CC\pm} = \pm 15\text{ V}$, $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TL07xM			TL07xC, TL07xAC, TL07xBC, TL07xI			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_I = 10\text{ V}$, $C_L = 100\text{ pF}$, $R_L = 2\text{ k}\Omega$, See Figure 20	5	13		8	13	V/ μs
t_r	Rise-time overshoot factor	$V_I = 20\text{ V}$, $C_L = 100\text{ pF}$, $R_L = 2\text{ k}\Omega$, See Figure 20	0.1			0.1		μs
			20%			20%		
V_n	Equivalent input noise voltage	$R_S = 20\ \Omega$	$f = 1\text{ kHz}$	18		18		$\text{nV}/\sqrt{\text{Hz}}$
			$f = 10\text{ Hz}$ to 10 kHz	4		4		μV
I_n	Equivalent input noise current	$R_S = 20\ \Omega$, $f = 1\text{ kHz}$	0.01		0.01			$\text{pA}/\sqrt{\text{Hz}}$
THD	Total harmonic distortion	$V_{I\text{rms}} = 6\text{ V}$, $R_L \geq 2\text{ k}\Omega$, $f = 1\text{ kHz}$, $A_{VD} = 1$, $R_S \leq 1\text{ k}\Omega$	0.003%		0.003%			

6.8 Typical Characteristics

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

Table 1. Table of Graphs

			Figure
I_{IB}	Input bias current	versus Free-air temperature	Figure 1
V_{OM}	Maximum peak output voltage	versus Frequency versus Free-air temperature versus Load resistance versus Supply voltage	Figure 2, Figure 3, Figure 4 Figure 5 Figure 6 Figure 7
A_{VD}	Large signal differential voltage amplification	versus Free-air temperature versus Load resistance	Figure 8 Figure 9
	Phase shift	versus Frequency	Figure 9
	Normalized unity-gain bandwidth	versus Free-air temperature	Figure 10
	Normalized phase shift	versus Free-air temperature	Figure 10
CMRR	Common-mode rejection ratio	versus Free-air temperature	Figure 11
I_{CC}	Supply current	versus Free-air temperature versus Supply voltage	Figure 12 Figure 13
P_D	Total power dissipation	versus Free-air temperature	Figure 14
	Normalized slew rate	versus Free-air temperature	Figure 15
V_n	Equivalent input noise voltage	versus Frequency	Figure 16
THD	Total harmonic distortion	versus Frequency	Figure 17
	Large-signal pulse response	versus Time	Figure 18
V_O	Output voltage	versus Elapsed time	Figure 19

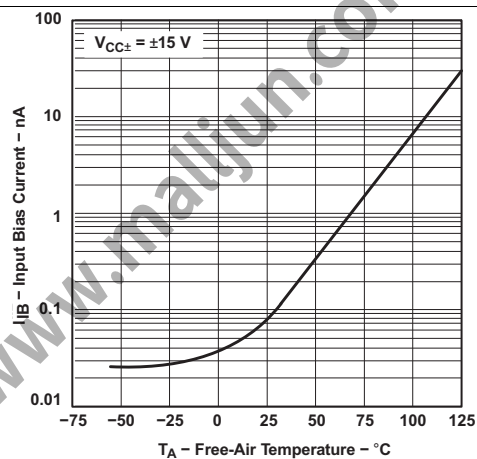


Figure 1. Input Bias Current vs Free-Air Temperature

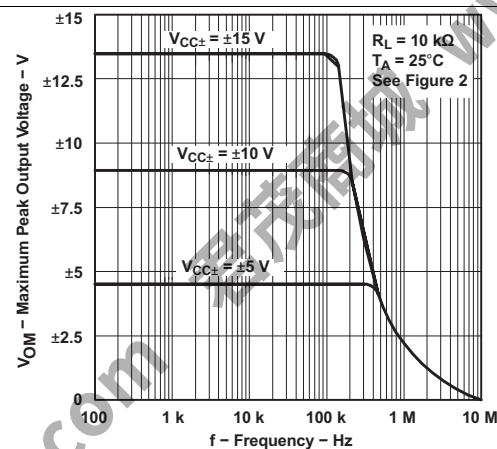


Figure 2. Maximum Peak Output Voltage vs Frequency

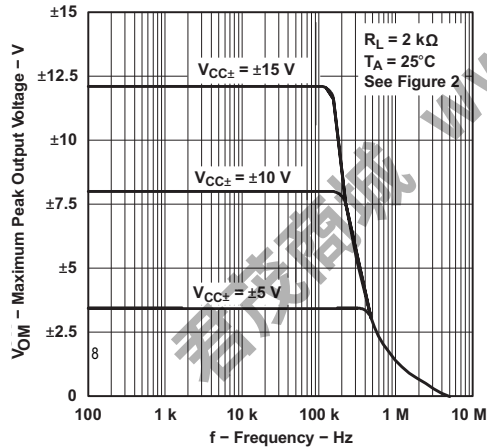


Figure 3. Maximum Peak Output Voltage vs Frequency

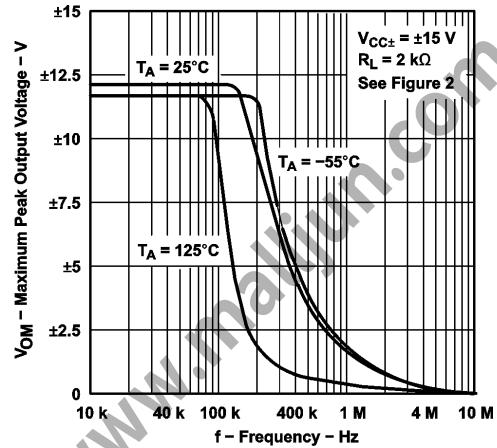


Figure 4. Maximum Peak Output Voltage vs Frequency

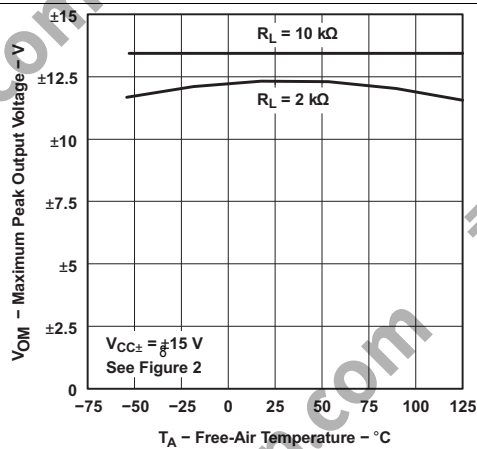


Figure 5. Maximum Peak Output Voltage vs Free-Air Temperature

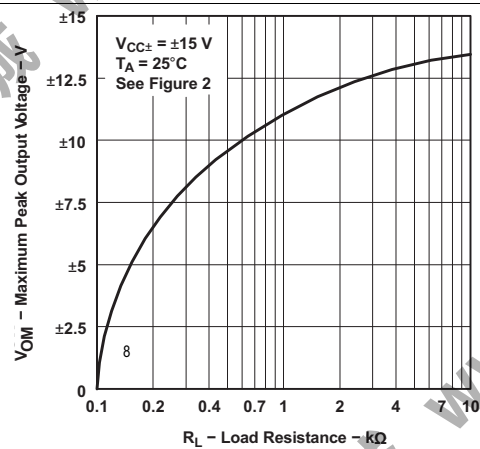


Figure 6. Maximum Peak Output Voltage vs Load Resistance

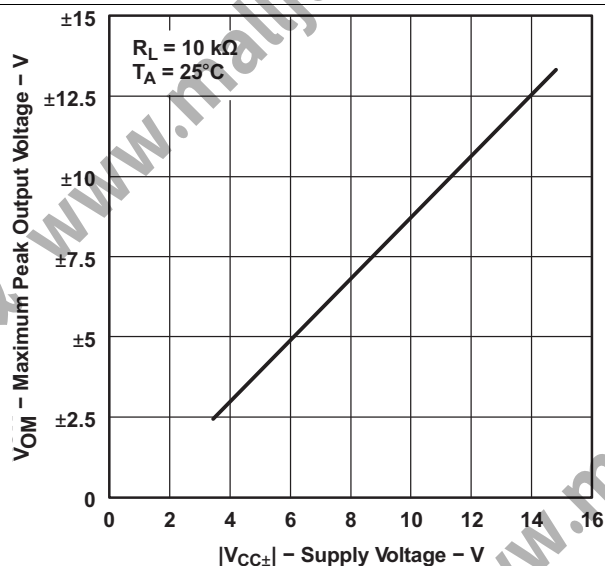


Figure 7. Maximum Peak Output Voltage vs Supply Voltage

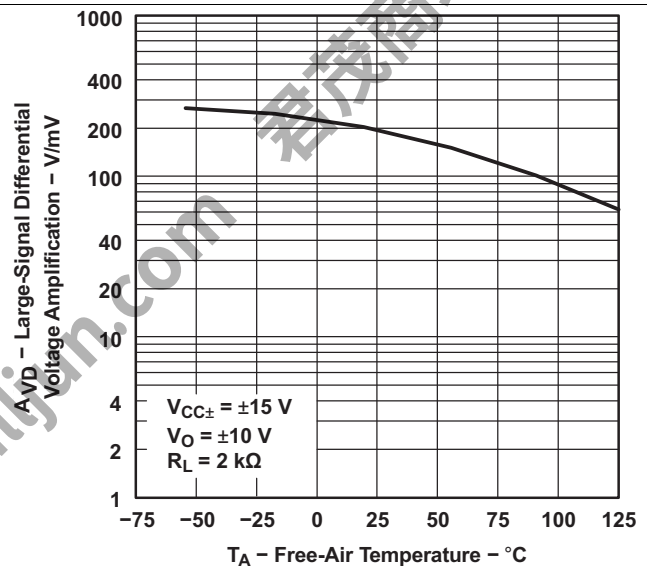


Figure 8. Large-Signal Differential Voltage Amplification vs Free-Air Temperature

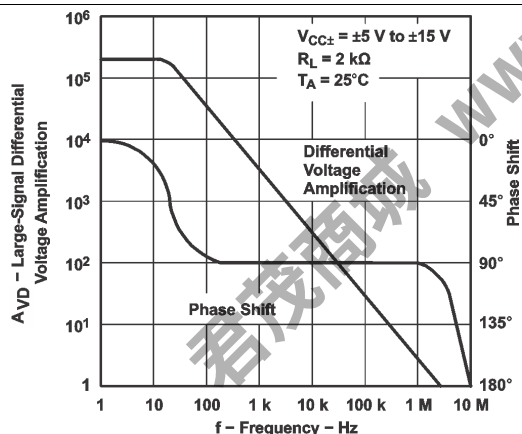


Figure 9. Large-Signal Differential Voltage Amplification and Phase Shift vs Frequency

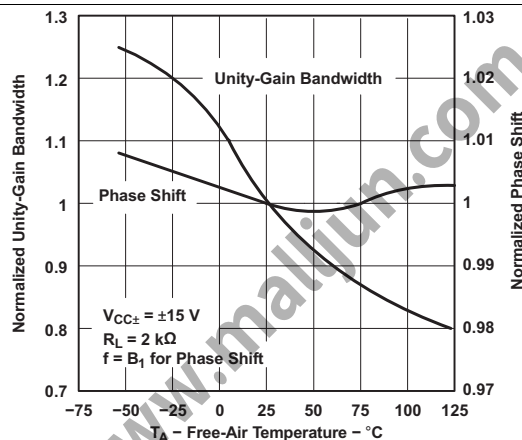


Figure 10. Normalized Unity-Gain Bandwidth and Phase Shift vs Free-Air Temperature

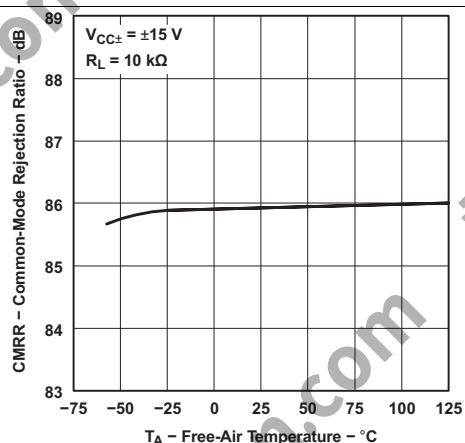


Figure 11. Common-Mode Rejection Ratio vs Free-Air Temperature

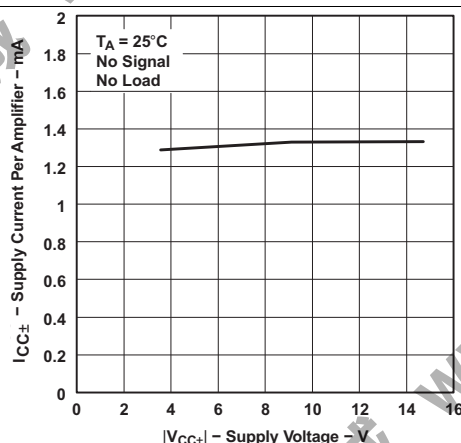


Figure 12. Supply Current Per Amplifier vs Supply Voltage

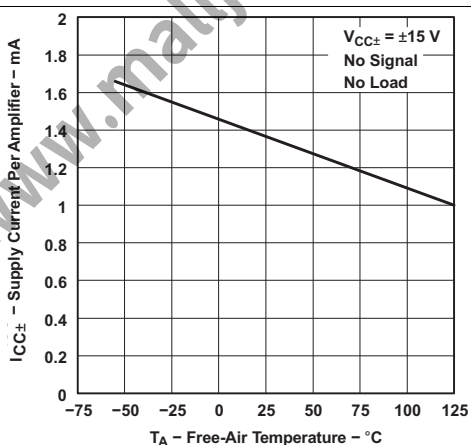


Figure 13. Supply Current Per Amplifier vs Free-Air Temperature

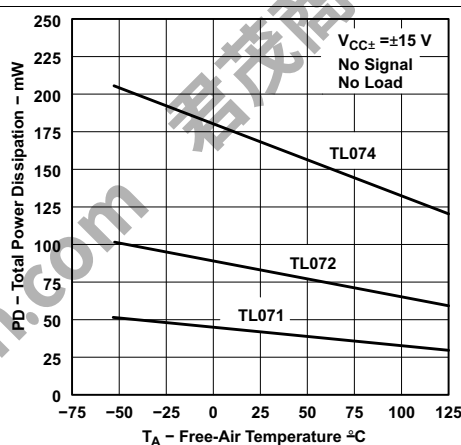


Figure 14. Total Power Dissipation vs Free-Air Temperature

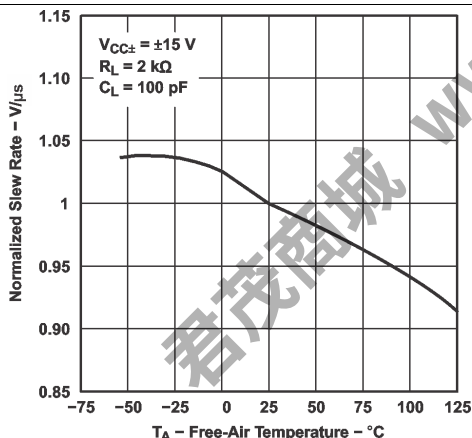


Figure 15. Normalized Slew Rate vs Free-Air Temperature

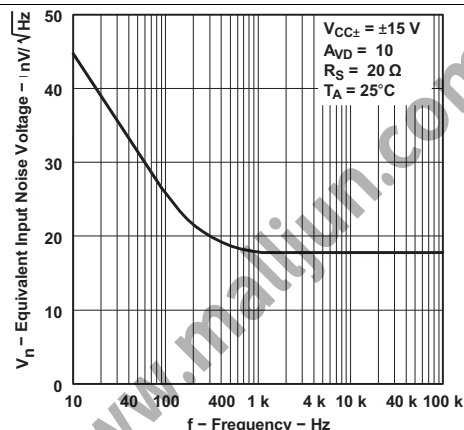


Figure 16. Equivalent Input Noise Voltage vs Frequency

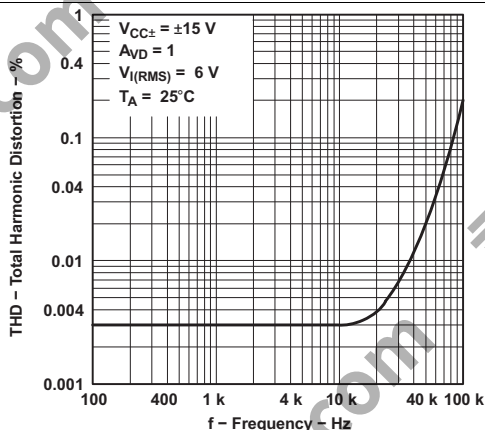


Figure 17. Total Harmonic Distortion vs Frequency

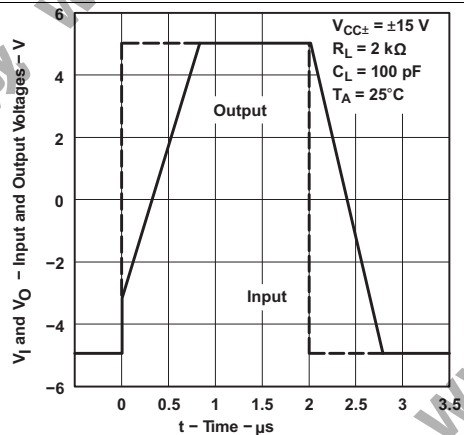


Figure 18. Voltage-Follower Large-Signal Pulse Response

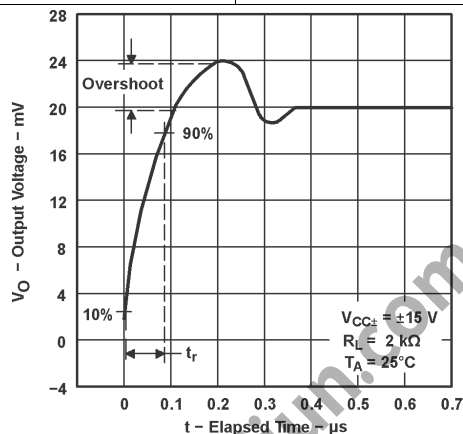


Figure 19. Output Voltage vs Elapsed Time

7 Parameter Measurement Information

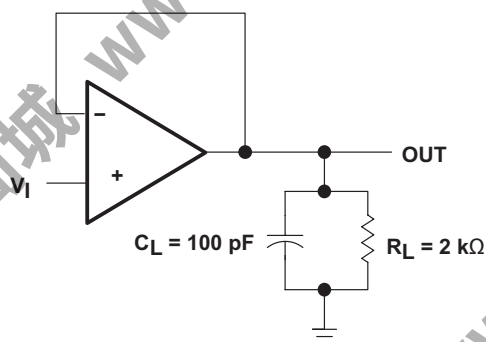


Figure 20. Unity-Gain Amplifier

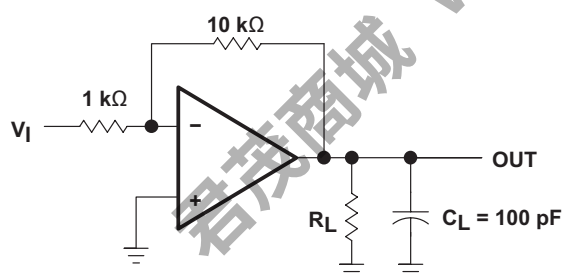


Figure 21. Gain-of-10 Inverting Amplifier

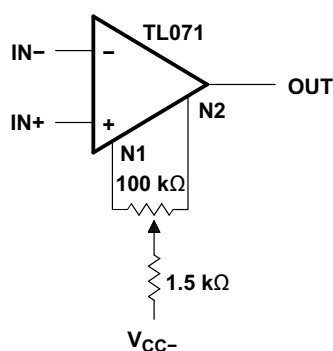


Figure 22. Input Offset-Voltage Null Circuit

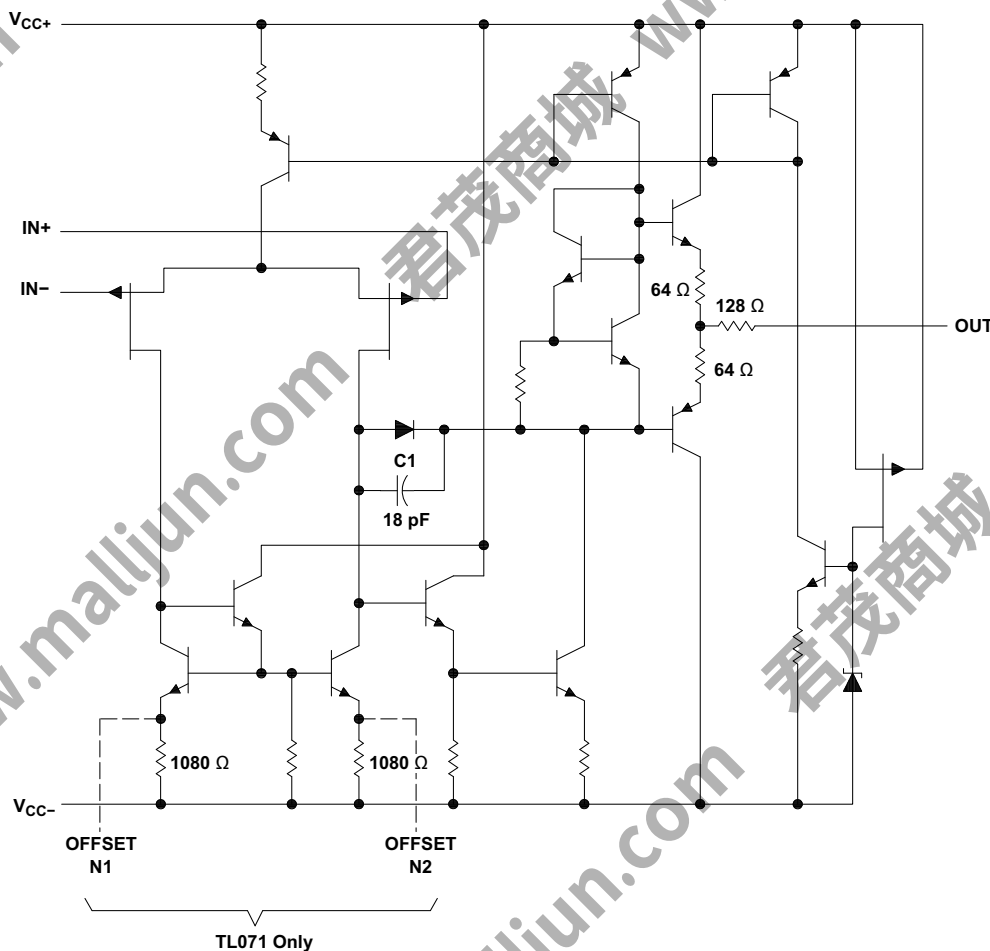
8 Detailed Description

8.1 Overview

The JFET-input operational amplifiers in the TL07xx series are similar to the TL08x series, with low input bias and offset currents and fast slew rate. The low harmonic distortion and low noise make the TL07xx series ideally suited for high-fidelity and audio preamplifier applications. Each amplifier features JFET inputs (for high input impedance) coupled with bipolar output stages integrated on a single monolithic chip.

The C-suffix devices are characterized for operation from 0°C to 70°C. The I-suffix devices are characterized for operation from –40°C to 85°C. The M-suffix devices are characterized for operation over the full military temperature range of –55°C to 125°C.

8.2 Functional Block Diagram



All component values shown are nominal.

COMPONENT COUNT†			
COMPONENT TYPE	TL071	TL072	TL074
Resistors	11	22	44
Transistors	14	28	56
JFET	2	4	6
Diodes	1	2	4
Capacitors	1	2	4
epi-FET	1	2	4

† Includes bias and trim circuitry

8.3 Feature Description

8.3.1 Total Harmonic Distortion

Harmonic distortions to an audio signal are created by electronic components in a circuit. Total harmonic distortion (THD) is a measure of harmonic distortions accumulated by a signal in an audio system. These devices have a very low THD of 0.003% meaning that the TL07x devices will add little harmonic distortion when used in audio signal applications.

8.3.2 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 13-V/ μ s slew rate.

8.4 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.

9 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.

9.1 Application Information

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.

9.2 Typical Application

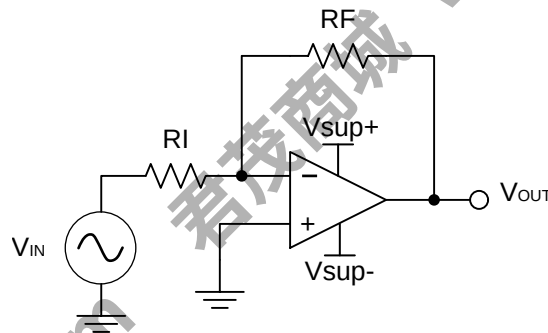


Figure 23. Inverting Amplifier

9.2.1 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 will scale a signal of ± 0.5 V to ± 1.8 V. Setting the supply at ± 12 V is sufficient to accommodate this application.

9.2.2 Detailed Design Procedure

Determine the gain required by the inverting amplifier:

$$A_v = \frac{V_{OUT}}{V_{IN}} \quad (1)$$

$$A_v = \frac{1.8}{-0.5} = -3.6 \quad (2)$$

Once the desired gain is determined, choose a value for R_I or R_F . Choosing a value in the kilohm range is desirable because the amplifier circuit will use currents in the milliamp range. This ensures the part will not draw too much current. This example will choose 10 k Ω for R_I which means 36 k Ω will be used for R_F . This was determined by [Equation 3](#).

$$A_v = -\frac{R_F}{R_I} \quad (3)$$

Typical Application (continued)

9.2.3 Application Curve

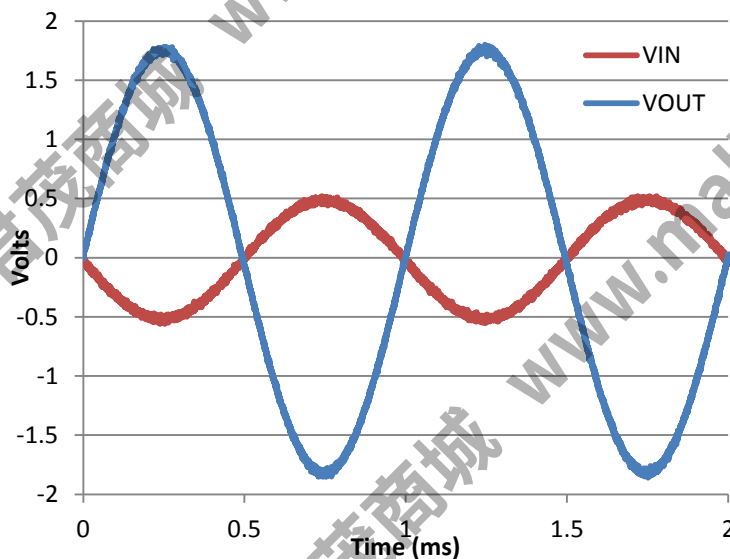


Figure 24. Input and Output Voltages of the Inverting Amplifier

9.3 System Examples

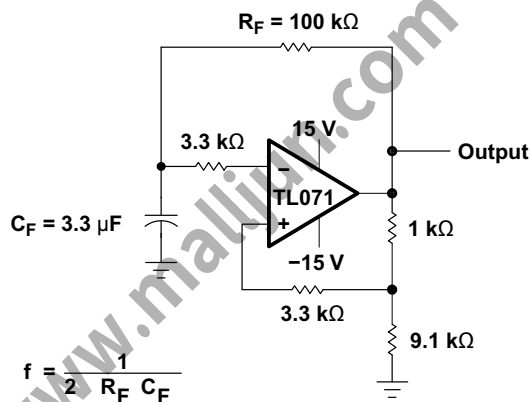


Figure 25. 0.5-Hz Square-Wave Oscillator

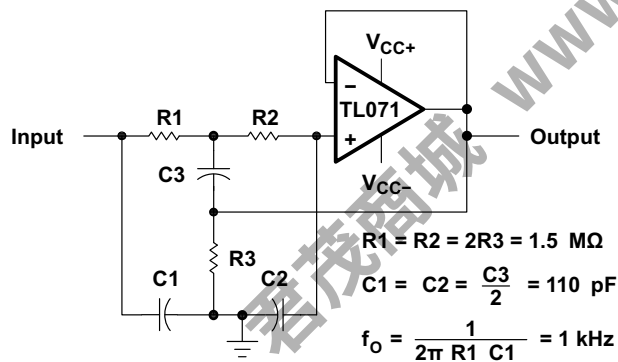


Figure 26. High-Q Notch Filter

System Examples (continued)

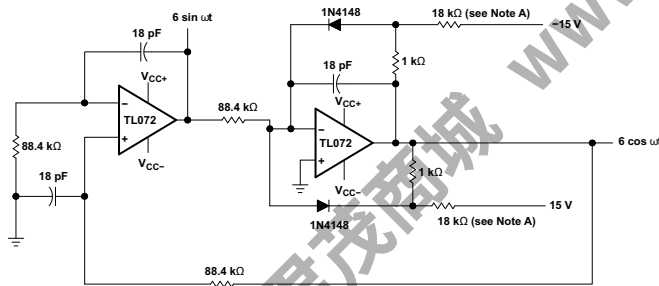


Figure 27. 100-kHz Quadrature Oscillator

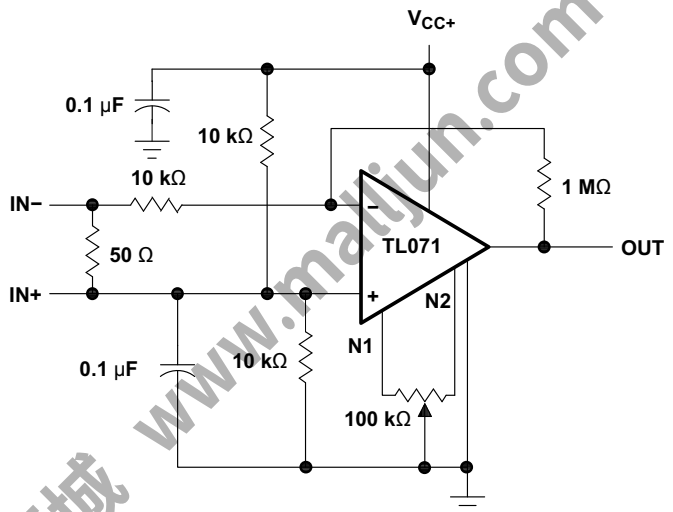


Figure 28. AC Amplifier

10 Power Supply Recommendations

CAUTION

Supply voltages larger than 36 V for a single-supply or outside the range of ± 18 V for a dual-supply 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, refer to the [Layout](#).

11 Layout

11.1 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. For more detailed information, refer to *Circuit Board Layout Techniques*, (SLOA089).
- 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.
- Place the external components as close to the device as possible. Keeping RF and RG close to the inverting input minimizes parasitic capacitance, as shown in [Layout Example](#).
- 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

Layout Guidelines (continued)

leakage currents from nearby traces that are at different potentials.

11.2 Layout Example

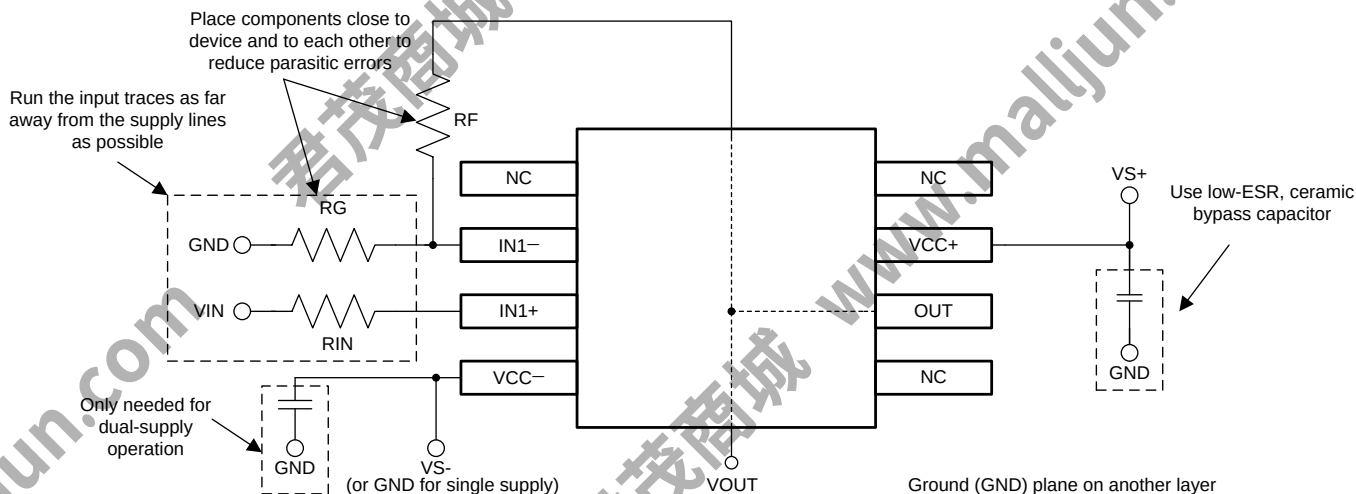


Figure 29. Operational Amplifier Board Layout for Noninverting Configuration

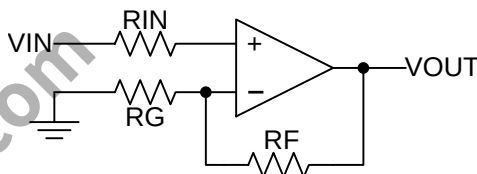


Figure 30. Operational Amplifier Schematic for Noninverting Configuration

12 Device and Documentation Support

12.1 Documentation Support

12.1.1 Related Documentation

For related documentation, see the following:

Circuit Board Layout Techniques, (SLOA089)

12.2 Related Links

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

Table 2. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
TL071	Click here	Click here	Click here	Click here	Click here
TL071A	Click here	Click here	Click here	Click here	Click here
TL071B	Click here	Click here	Click here	Click here	Click here
TL072	Click here	Click here	Click here	Click here	Click here
TL072A	Click here	Click here	Click here	Click here	Click here
TL072B	Click here	Click here	Click here	Click here	Click here
TL074	Click here	Click here	Click here	Click here	Click here
TL074A	Click here	Click here	Click here	Click here	Click here
TL074B	Click here	Click here	Click here	Click here	Click here

12.3 Community Resources

The following links connect to TI community resources. Linked contents are 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](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.4 Trademarks

E2E is a trademark of Texas Instruments.

All other trademarks are the property of their respective owners.

12.5 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

12.6 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 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 revision of this document. For browser based versions of this data sheet, refer to the left hand navigation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
8102304HA	OBSOLETE			10		TBD	Call TI	Call TI	-55 to 125		
81023052A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	81023052A TL072MFKB	Samples
8102305HA	ACTIVE	CFP	U	10	1	TBD	A42	N / A for Pkg Type	-55 to 125	8102305HA TL072M	Samples
8102305PA	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	8102305PA TL072M	Samples
81023062A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	81023062A TL074MFKB	Samples
8102306CA	ACTIVE	CDIP	J	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	8102306CA TL074MJB	Samples
8102306DA	ACTIVE	CFP	W	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	8102306DA TL074MWB	Samples
JM38510/11905BPA	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	JM38510 /11905BPA	Samples
JM38510/11906BCA	ACTIVE	CDIP	J	14	25	TBD	Call TI	Call TI	-55 to 125	JL147BCA JM38510/11906BCA Q	Samples
M38510/11905BPA	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	JM38510 /11905BPA	Samples
TL071-W	ACTIVE	WAFERSALE	YS	0		TBD	Call TI	Call TI			Samples
TL071ACD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	071AC	Samples
TL071ACDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	071AC	Samples
TL071ACDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	071AC	Samples
TL071ACP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL071ACP	Samples
TL071ACPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL071ACP	Samples
TL071BCD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	071BC	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TL071BCDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	071BC	Samples
TL071BCDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	071BC	Samples
TL071BCDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	071BC	Samples
TL071BCP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL071BCP	Samples
TL071BCPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL071BCP	Samples
TL071CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL071C	Samples
TL071CDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL071C	Samples
TL071CDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL071C	Samples
TL071CDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL071C	Samples
TL071CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL071CP	Samples
TL071CPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL071CP	Samples
TL071CPSR	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	T071	Samples
TL071CPSRG4	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	T071	Samples
TL071CPWLE	OBSOLETE	TSSOP	PW	8		TBD	Call TI	Call TI	0 to 70		
TL071ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL071I	Samples
TL071IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL071I	Samples
TL071IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL071I	Samples
TL071IJG	OBSOLETE	CDIP	JG	8		TBD	Call TI	Call TI	-40 to 85		
TL071IP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	TL071IP	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TL071IPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	TL071IP	Samples
TL071MFKB	OBSOLETE	LCCC	FK	20		TBD	Call TI	Call TI	-55 to 125		
TL071MJG	OBSOLETE	CDIP	JG	8		TBD	Call TI	Call TI	-55 to 125		
TL071MJGB	OBSOLETE	CDIP	JG	8		TBD	Call TI	Call TI	-55 to 125		
TL072ACD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	072AC	Samples
TL072ACDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	072AC	Samples
TL072ACDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	072AC	Samples
TL072ACDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	072AC	Samples
TL072ACDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	072AC	Samples
TL072ACJG	OBSOLETE	CDIP	JG	8		TBD	Call TI	Call TI	0 to 70		
TL072ACP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL072ACP	Samples
TL072ACPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL072ACP	Samples
TL072ACPSR	OBSOLETE	SO	PS	8		TBD	Call TI	Call TI	0 to 70		
TL072ACPSRE4	OBSOLETE	SO	PS	8		TBD	Call TI	Call TI	0 to 70		
TL072ACPSRG4	OBSOLETE	SO	PS	8		TBD	Call TI	Call TI	0 to 70		
TL072BCD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	072BC	Samples
TL072BCDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	072BC	Samples
TL072BCDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	072BC	Samples
TL072BCDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	072BC	Samples
TL072BCDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	072BC	Samples
TL072BCDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	072BC	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TL072BCP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL072BCP	Samples
TL072BCPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL072BCP	Samples
TL072CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL072C	Samples
TL072CDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL072C	Samples
TL072CDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL072C	Samples
TL072CDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL072C	Samples
TL072CDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL072C	Samples
TL072CDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL072C	Samples
TL072CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL072CP	Samples
TL072CPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL072CP	Samples
TL072CPSLE	OBSOLETE	SO	PS	8		TBD	Call TI	Call TI	0 to 70		
TL072CPSR	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	T072	Samples
TL072CPSRE4	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	T072	Samples
TL072CPSRG4	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	T072	Samples
TL072CPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	T072	Samples
TL072CPWRE4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	T072	Samples
TL072CPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	T072	Samples
TL072ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL072I	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TL072IDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL072I	Samples
TL072IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL072I	Samples
TL072IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL072I	Samples
TL072IDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL072I	Samples
TL072IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL072I	Samples
TL072IP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	TL072IP	Samples
TL072IPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	TL072IP	Samples
TL072MFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	81023052A TL072MFKB	Samples
TL072MJG	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	TL072MJG	Samples
TL072MJGB	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	8102305PA TL072M	Samples
TL072MUB	ACTIVE	CFP	U	10	1	TBD	A42	N / A for Pkg Type	-55 to 125	8102305HA TL072M	Samples
TL074ACD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074AC	Samples
TL074ACDE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074AC	Samples
TL074ACDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074AC	Samples
TL074ACDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074AC	Samples
TL074ACDRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074AC	Samples
TL074ACDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074AC	Samples
TL074ACJ	OBSOLETE	CDIP	J	14		TBD	Call TI	Call TI	0 to 70		

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TL074ACN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL074ACN	Samples
TL074ACNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL074ACN	Samples
TL074ACNSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074A	Samples
TL074BCD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074BC	Samples
TL074BCDE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074BC	Samples
TL074BCDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074BC	Samples
TL074BCDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074BC	Samples
TL074BCDRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074BC	Samples
TL074BCDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074BC	Samples
TL074BCN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL074BCN	Samples
TL074BCNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL074BCN	Samples
TL074CD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074C	Samples
TL074CDE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074C	Samples
TL074CDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074C	Samples
TL074CDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU CU SN	Level-1-260C-UNLIM	0 to 70	TL074C	Samples
TL074CDRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074C	Samples
TL074CDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074C	Samples
TL074CN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL074CN	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TL074CNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TL074CN	Samples
TL074CNSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074	Samples
TL074CNSRG4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TL074	Samples
TL074CPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	T074	Samples
TL074CPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	T074	Samples
TL074CPWLE	OBSOLETE	TSSOP	PW	14		TBD	Call TI	Call TI	0 to 70		
TL074CPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	T074	Samples
TL074CPWRE4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	T074	Samples
TL074CPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	T074	Samples
TL074ID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL074I	Samples
TL074IDE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL074I	Samples
TL074IDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL074I	Samples
TL074IDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL074I	Samples
TL074IDRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL074I	Samples
TL074IDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TL074I	Samples
TL074IJ	OBSOLETE	CDIP	J	14		TBD	Call TI	Call TI	-40 to 85		
TL074IN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	TL074IN	Samples
TL074INE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	TL074IN	Samples
TL074MFK	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	TL074MFK	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TL074MFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	81023062A TL074MFKB	Samples
TL074MJ	ACTIVE	CDIP	J	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	TL074MJ	Samples
TL074MJB	ACTIVE	CDIP	J	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	8102306CA TL074MJB	Samples
TL074MWB	ACTIVE	CFP	W	14	1	TBD	A42	N / A for Pkg Type	-55 to 125	8102306DA TL074MWB	Samples
TL081-W	ACTIVE	WAFERSALE	YS	0		TBD	Call TI	Call TI			Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSELETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

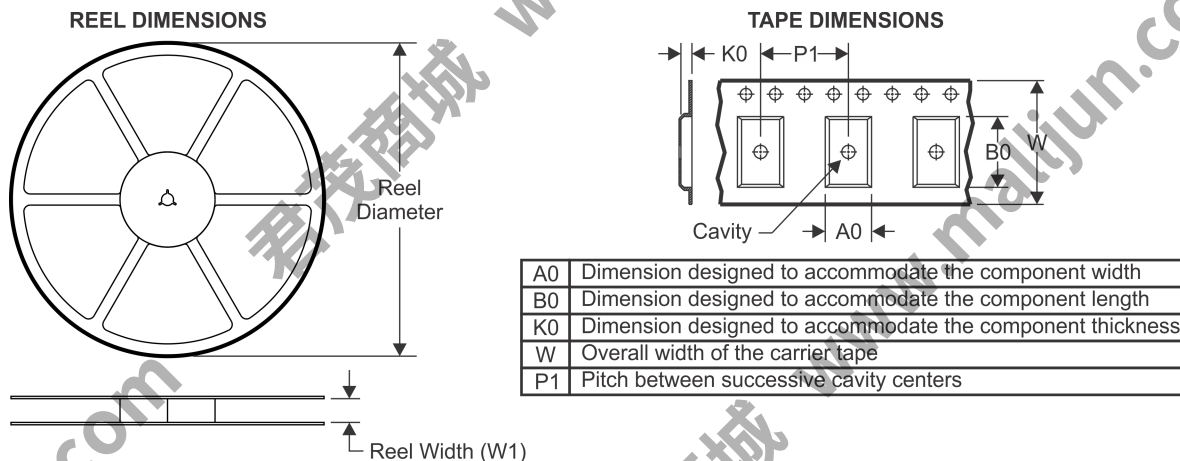
OTHER QUALIFIED VERSIONS OF TL072, TL072M, TL074, TL074M :

- Catalog: [TL072](#), [TL074](#)
- Enhanced Product: [TL072-EP](#), [TL072-EP](#), [TL074-EP](#), [TL074-EP](#)
- Military: [TL072M](#), [TL074M](#)

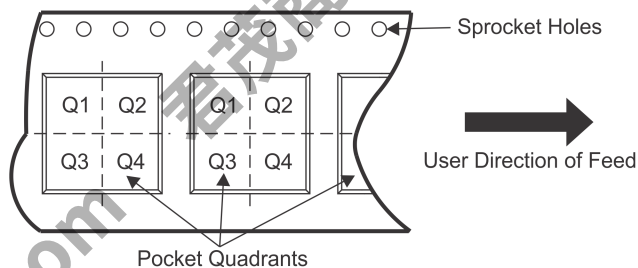
NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications
- Military - QML certified for Military and Defense Applications

TAPE AND REEL INFORMATION



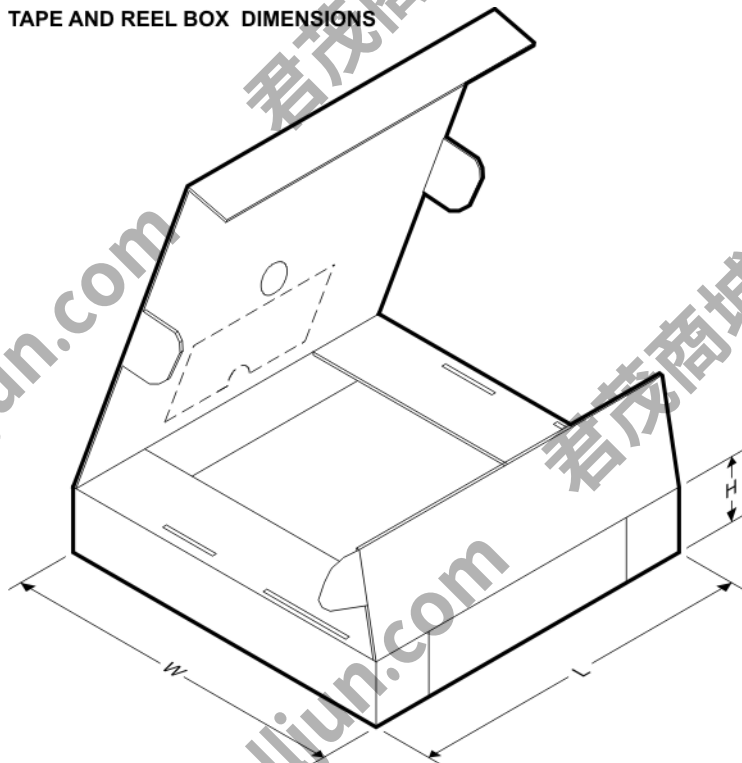
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TL071ACDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL071BCDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL071CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL071CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL071CPSR	SO	PS	8	2000	330.0	16.4	8.2	6.6	2.5	12.0	16.0	Q1
TL071IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL072ACDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL072BCDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL072CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL072CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL072CPWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
TL072IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL072IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL074ACDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TL074ACNSR	SO	NS	14	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
TL074BCDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TL074CDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TL074CDRG4	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	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
TL074CPWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TL074IDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS


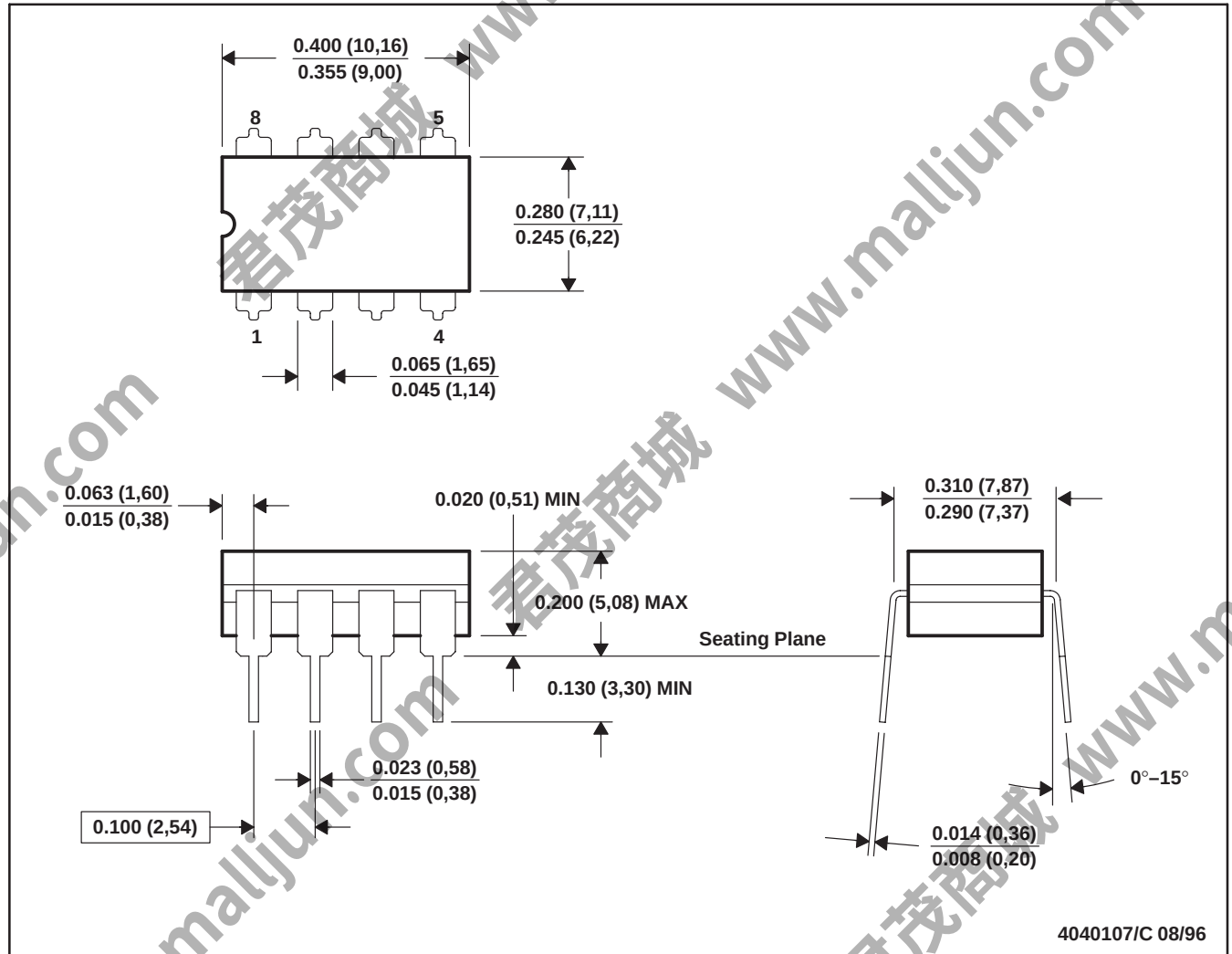
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL071ACDR	SOIC	D	8	2500	340.5	338.1	20.6
TL071BCDR	SOIC	D	8	2500	340.5	338.1	20.6
TL071CDR	SOIC	D	8	2500	340.5	338.1	20.6
TL071CDR	SOIC	D	8	2500	367.0	367.0	35.0
TL071CPSR	SO	PS	8	2000	367.0	367.0	38.0
TL071IDR	SOIC	D	8	2500	340.5	338.1	20.6
TL072ACDR	SOIC	D	8	2500	340.5	338.1	20.6
TL072BCDR	SOIC	D	8	2500	340.5	338.1	20.6
TL072CDR	SOIC	D	8	2500	340.5	338.1	20.6
TL072CDR	SOIC	D	8	2500	367.0	367.0	35.0
TL072CPWR	TSSOP	PW	8	2000	367.0	367.0	35.0
TL072IDR	SOIC	D	8	2500	367.0	367.0	35.0
TL072IDR	SOIC	D	8	2500	340.5	338.1	20.6
TL074ACDR	SOIC	D	14	2500	333.2	345.9	28.6
TL074ACNSR	SO	NS	14	2000	367.0	367.0	38.0

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL074BCDR	SOIC	D	14	2500	333.2	345.9	28.6
TL074CDR	SOIC	D	14	2500	333.2	345.9	28.6
TL074CDRG4	SOIC	D	14	2500	333.2	345.9	28.6
TL074CPWR	TSSOP	PW	14	2000	367.0	367.0	35.0
TL074IDR	SOIC	D	14	2500	333.2	345.9	28.6

JG (R-GDIP-T8)

CERAMIC DUAL-IN-LINE

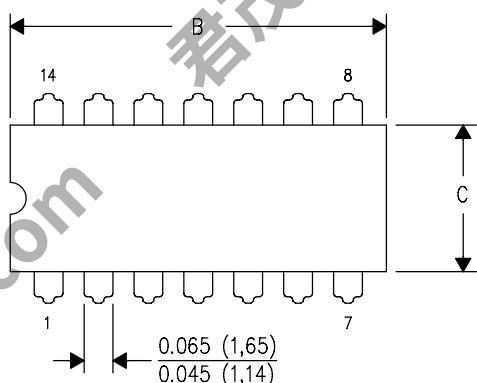


- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. This package can be hermetically sealed with a ceramic lid using glass frit.
 D. Index point is provided on cap for terminal identification.
 E. Falls within MIL STD 1835 GDIP1-T8

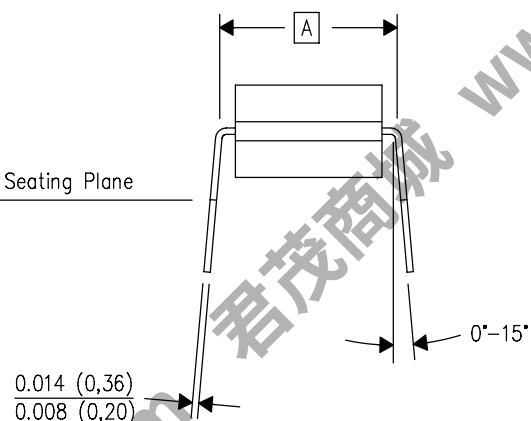
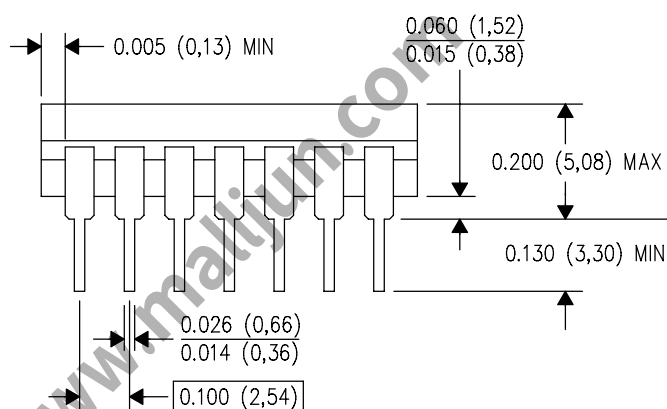
J (R-GDIP-T**)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



PINS **	14	16	18	20
DIM				
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)

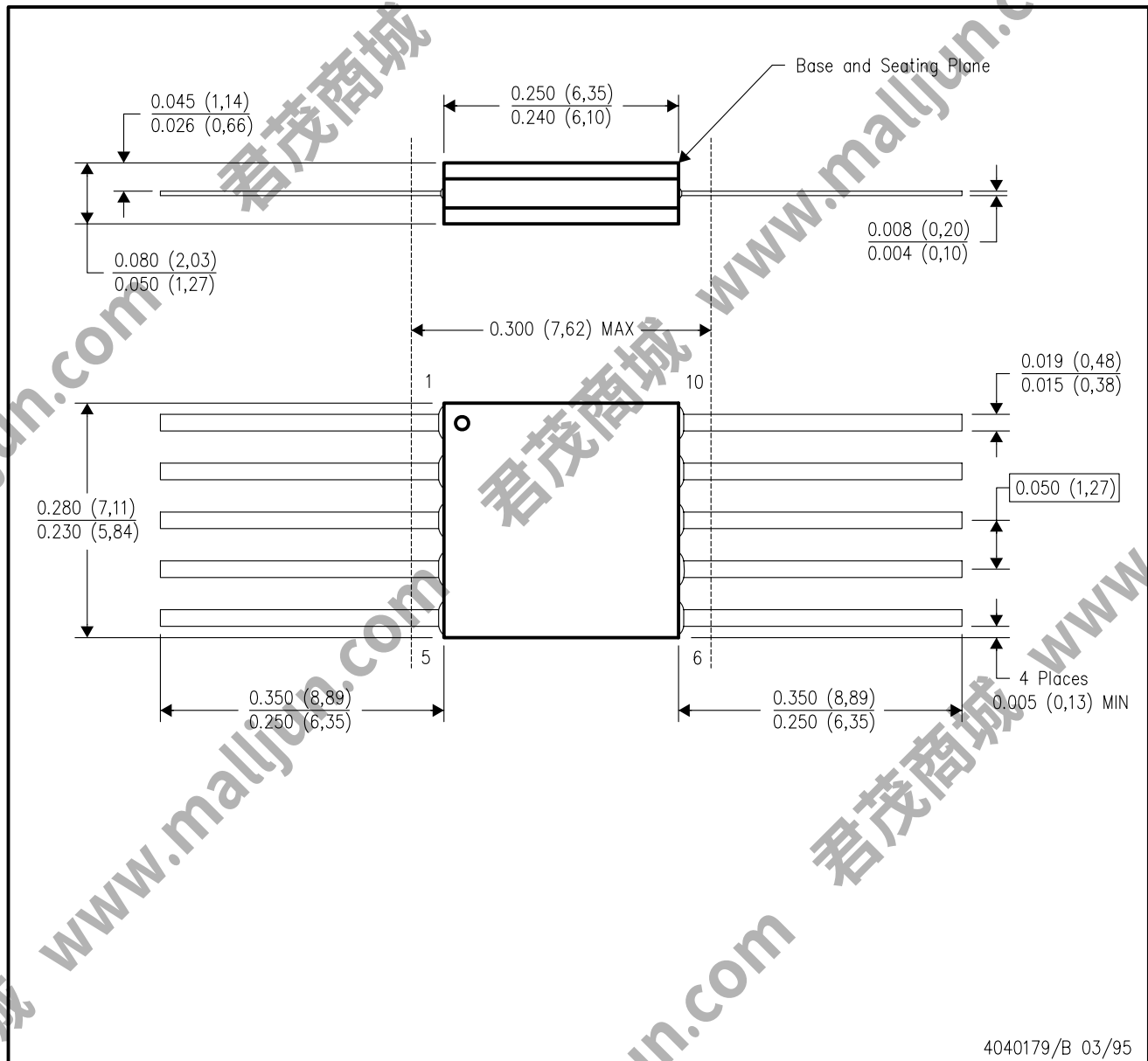


4040083/F 03/03

- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package is hermetically sealed with a ceramic lid using glass frit.
 - D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
 - E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

U (S-GDFP-F10)

CERAMIC DUAL FLATPACK



- 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 only.
 - E. Falls within MIL STD 1835 GDFP1-F10 and JEDEC MO-092AA

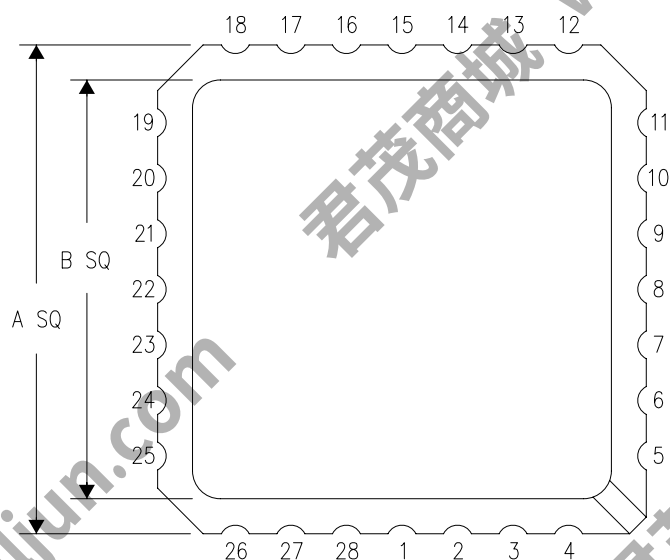
NOTES:

- 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 only.
E. Falls within MIL STD 1835 GDFP1-F14

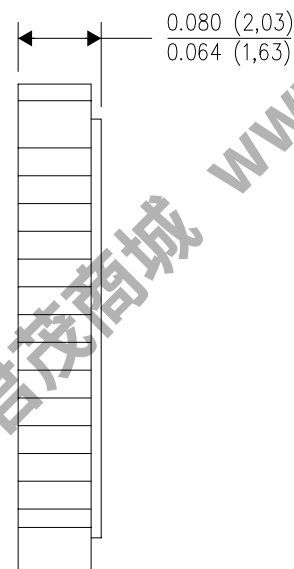
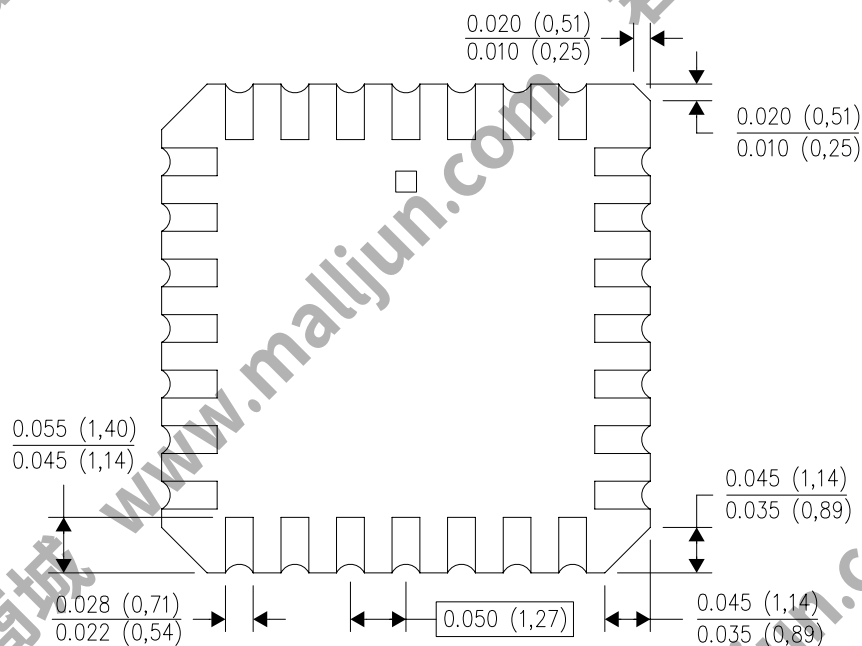
FK (S-CQCC-N**)

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)

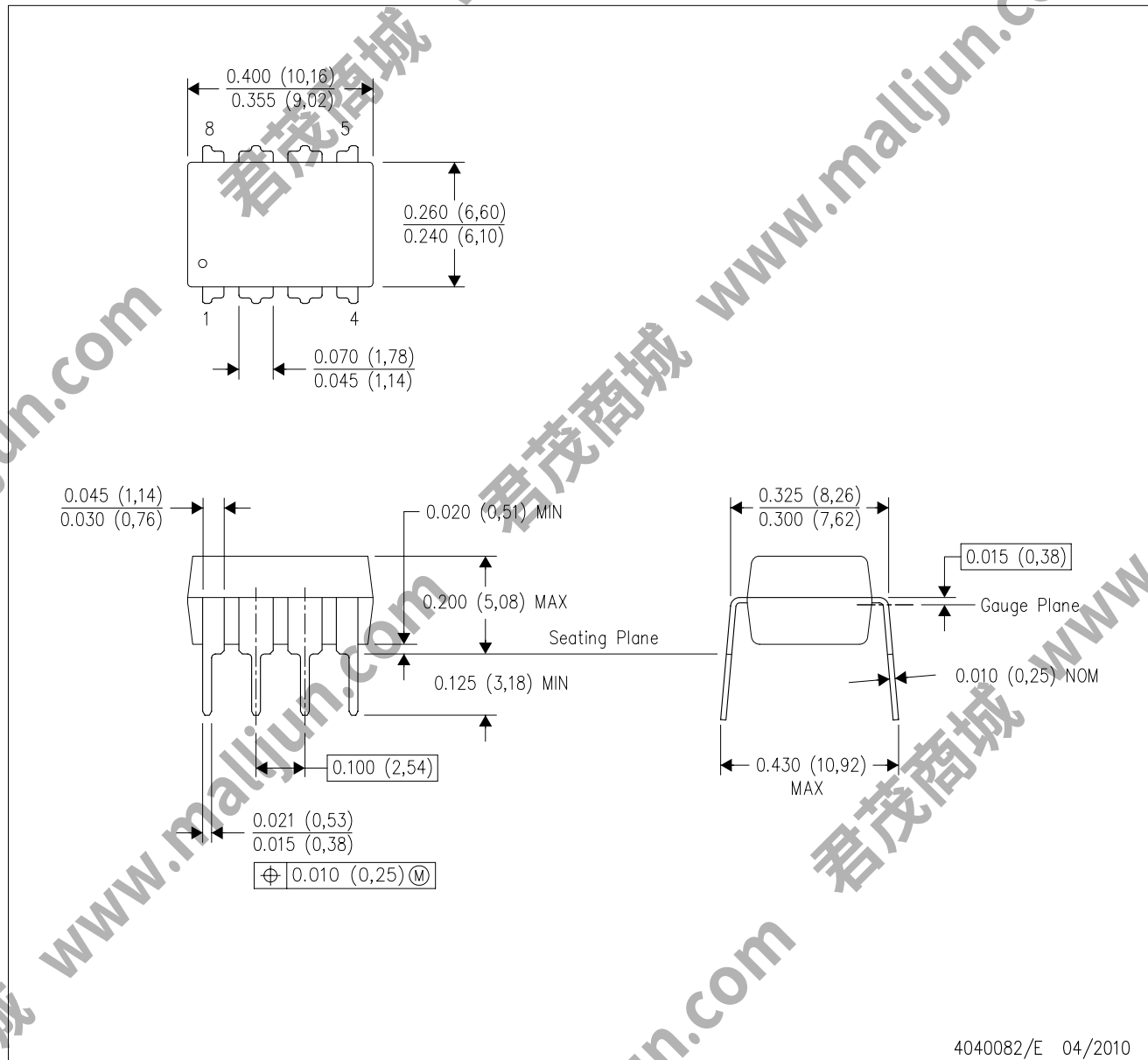


4040140/D 01/11

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

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



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

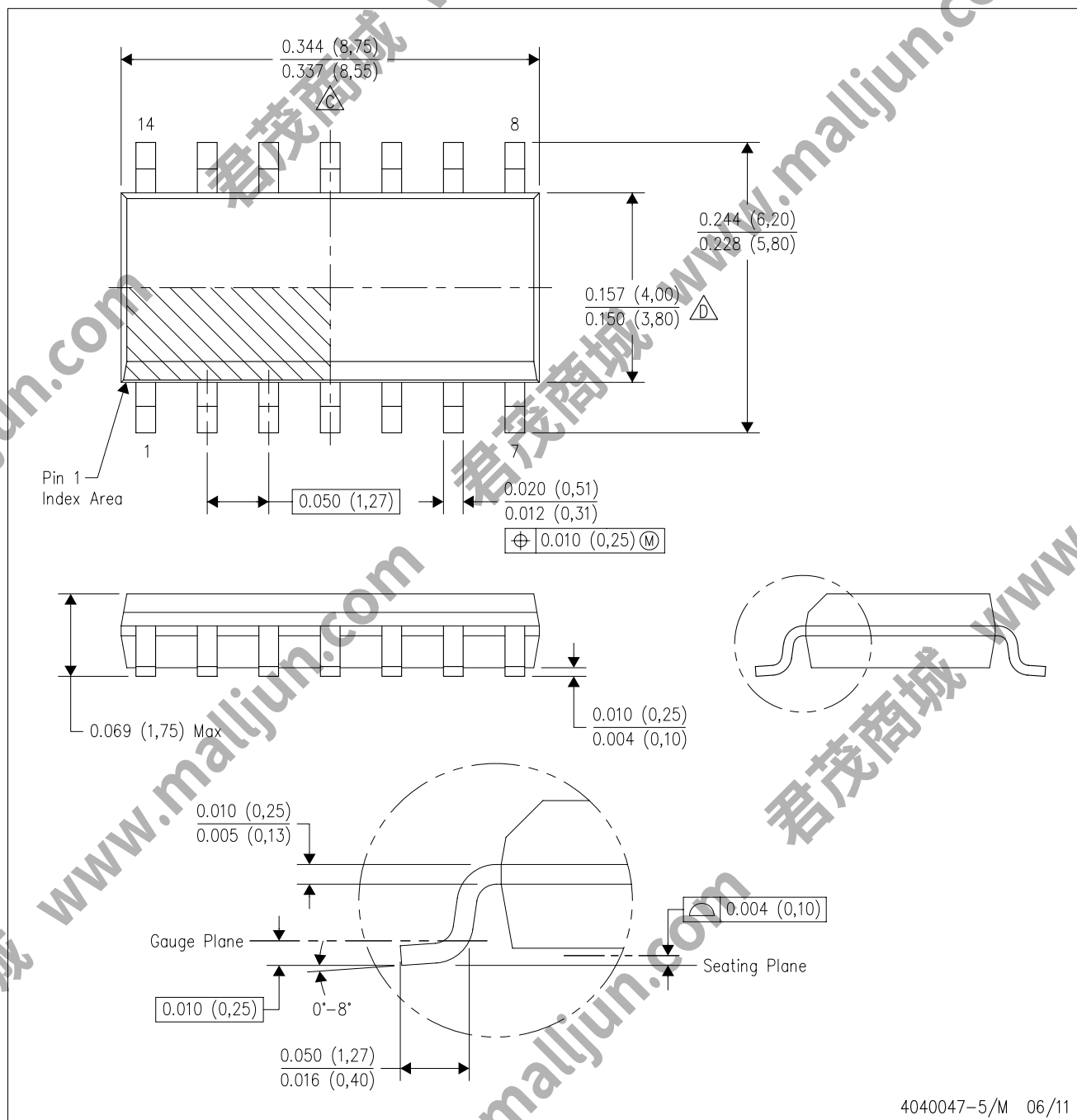
16 PINS SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 -  Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 -  The 20 pin end lead shoulder width is a vendor option, either half or full width.

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



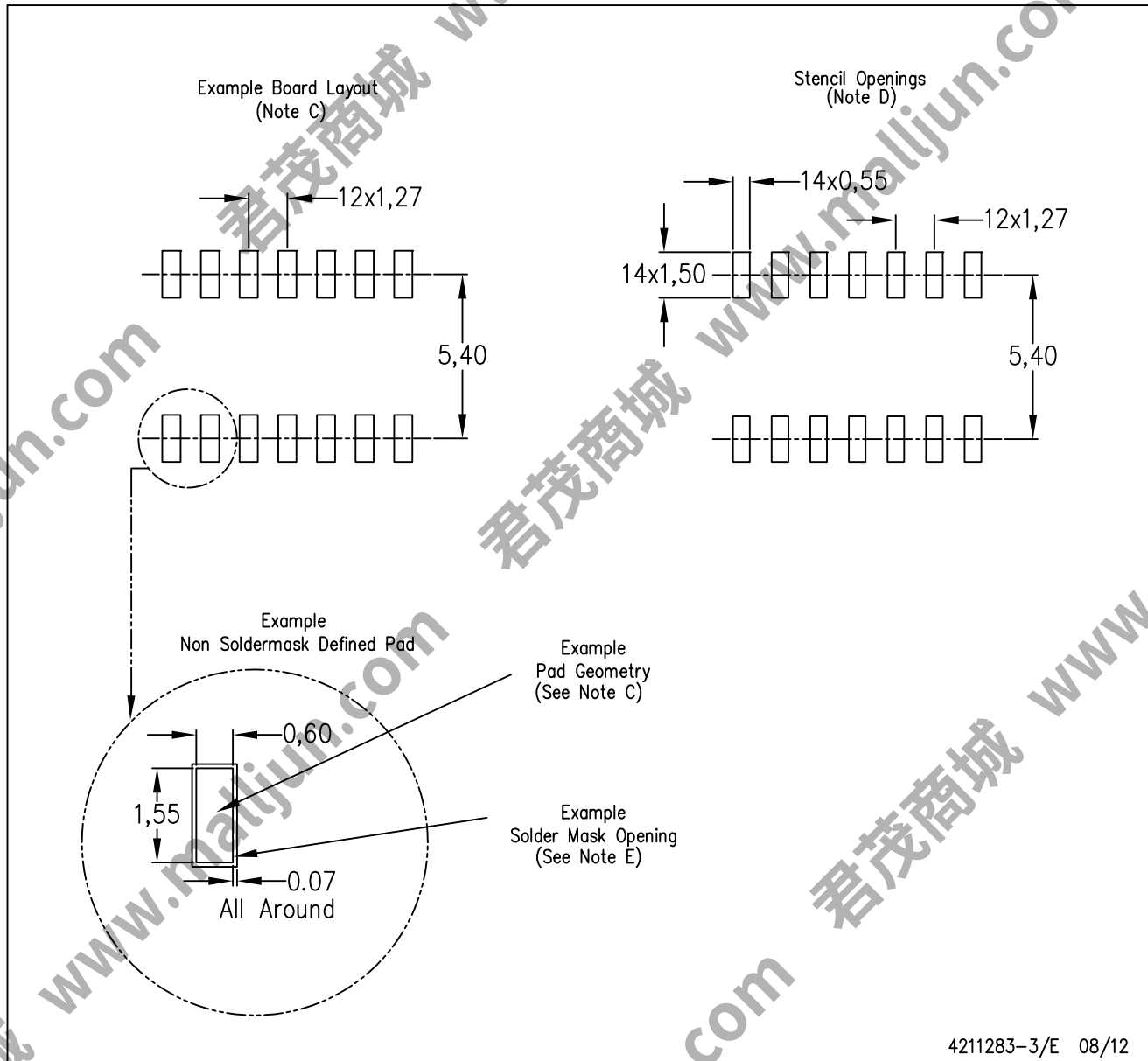
4040047-5/M 06/11

NOTES:

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

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



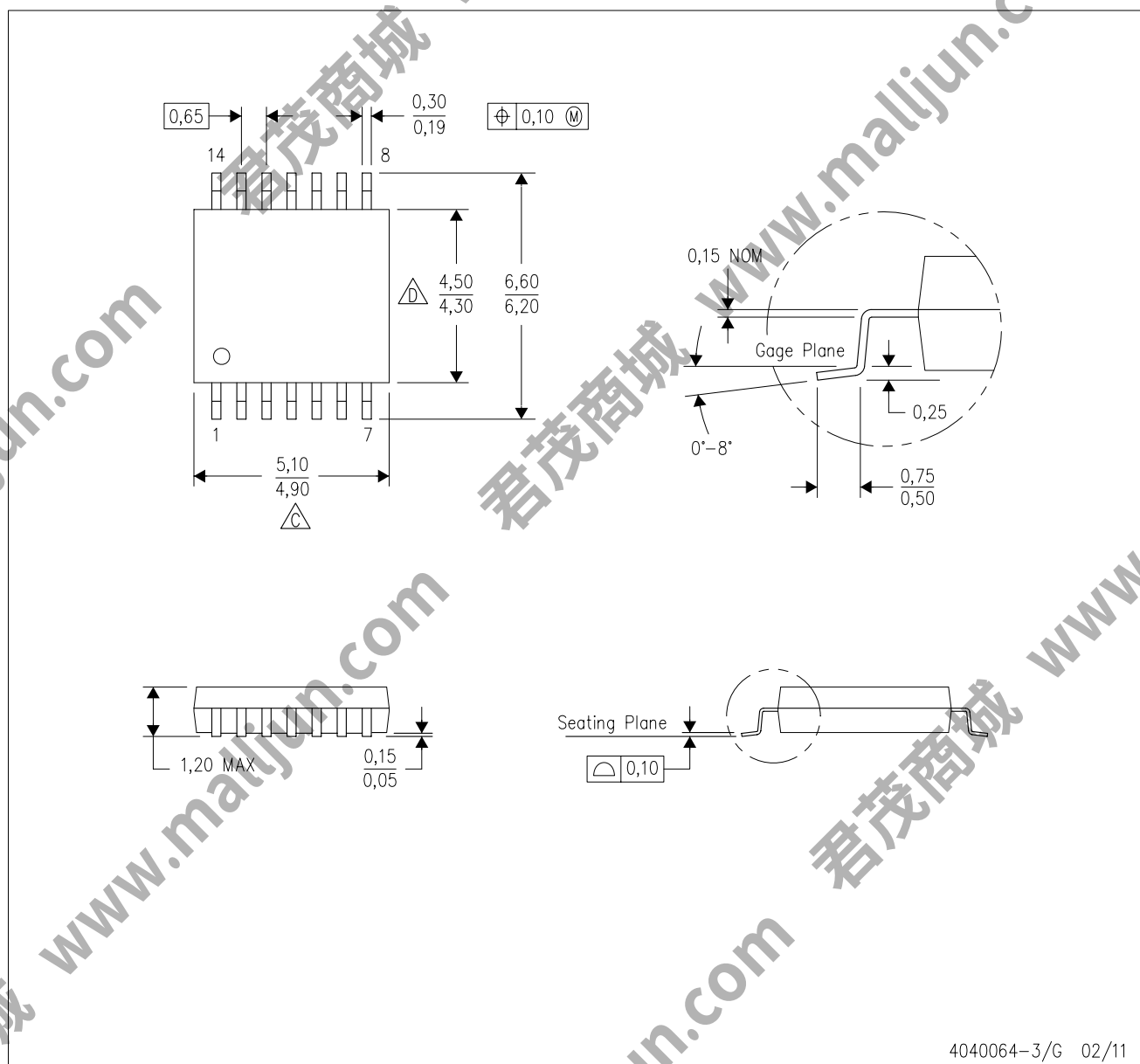
NOTES:

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

MECHANICAL DATA

PW (R-PDSO-G14)

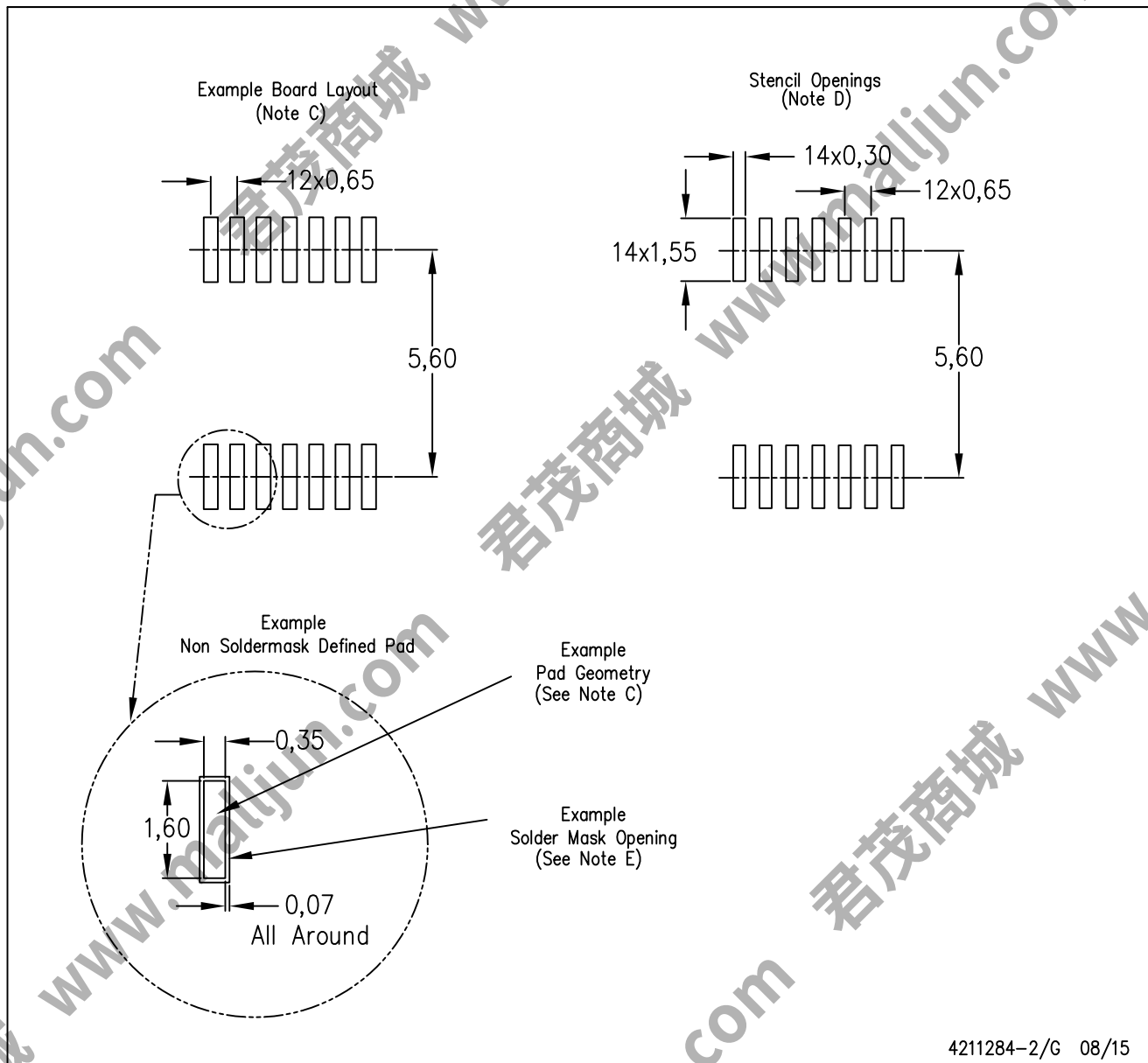
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - $\triangle C$ Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
 - $\triangle D$ Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
 - E. Falls within JEDEC MO-153

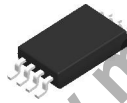
PW (R-PDSO-G14)

PLASTIC SMALL OUTLINE



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

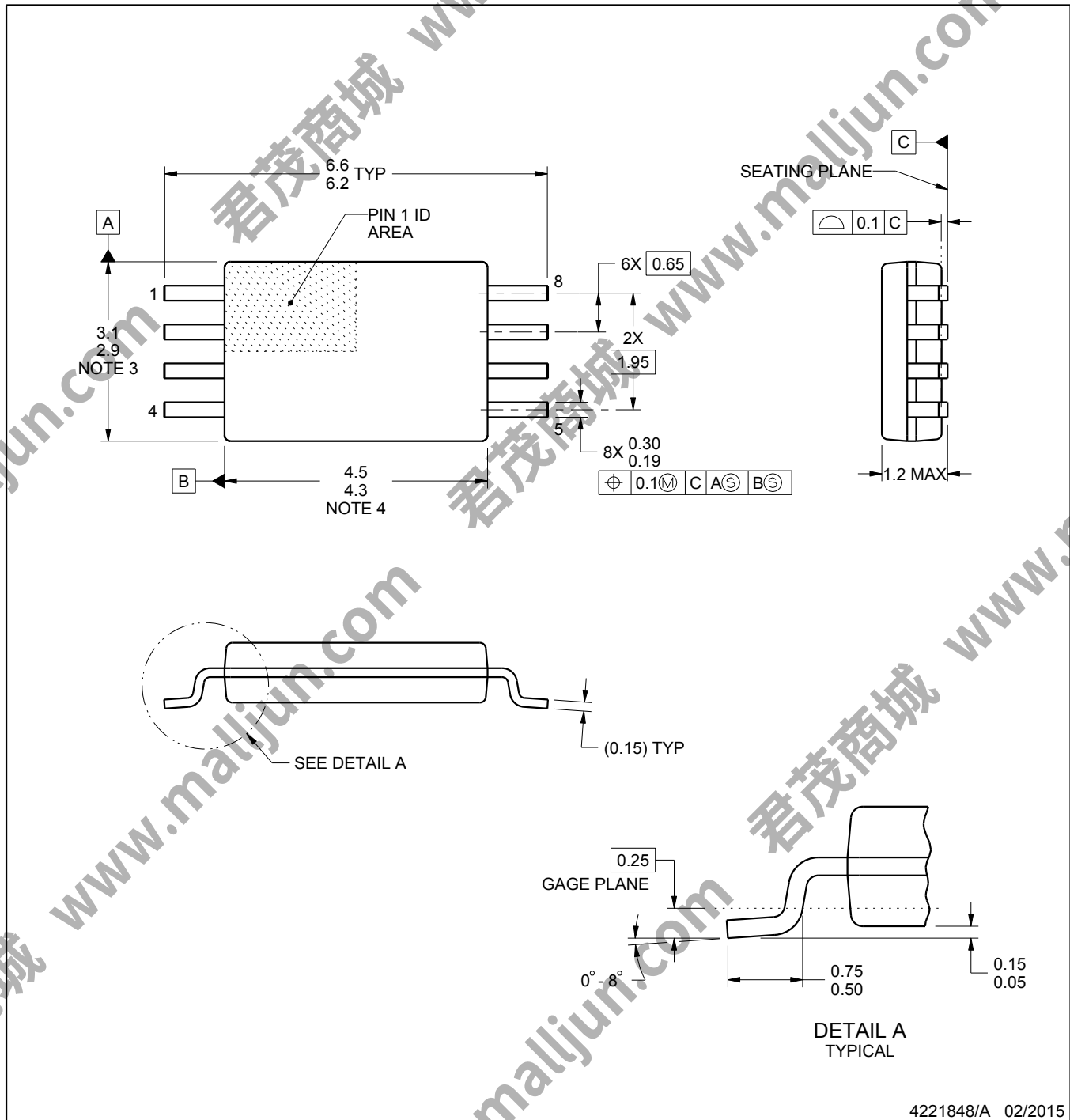
PW0008A



PACKAGE OUTLINE

TSSOP - 1.2 mm max height

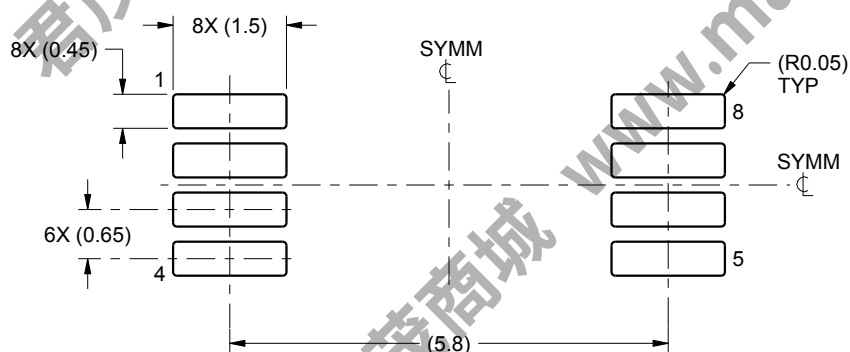
SMALL OUTLINE PACKAGE



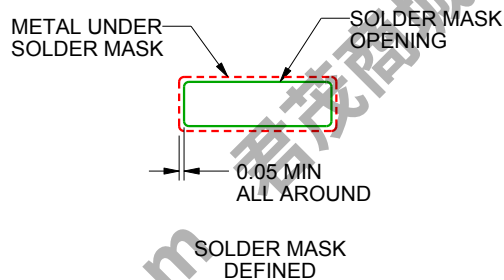
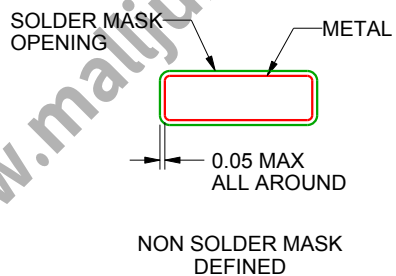
4221848/A 02/2015

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.

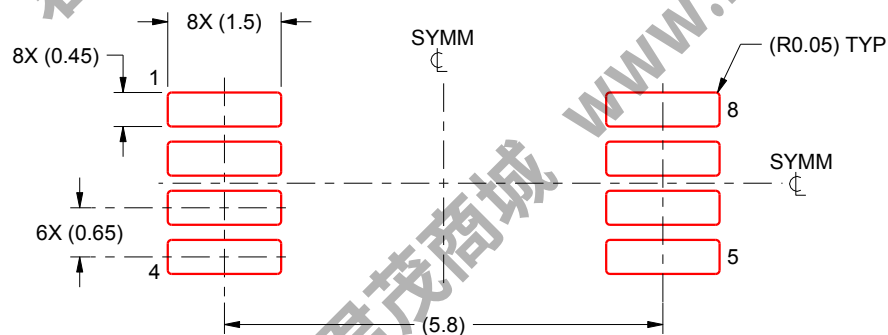


EXAMPLE STENCIL DESIGN

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

4221848/A 02/2015

NOTES: (continued)

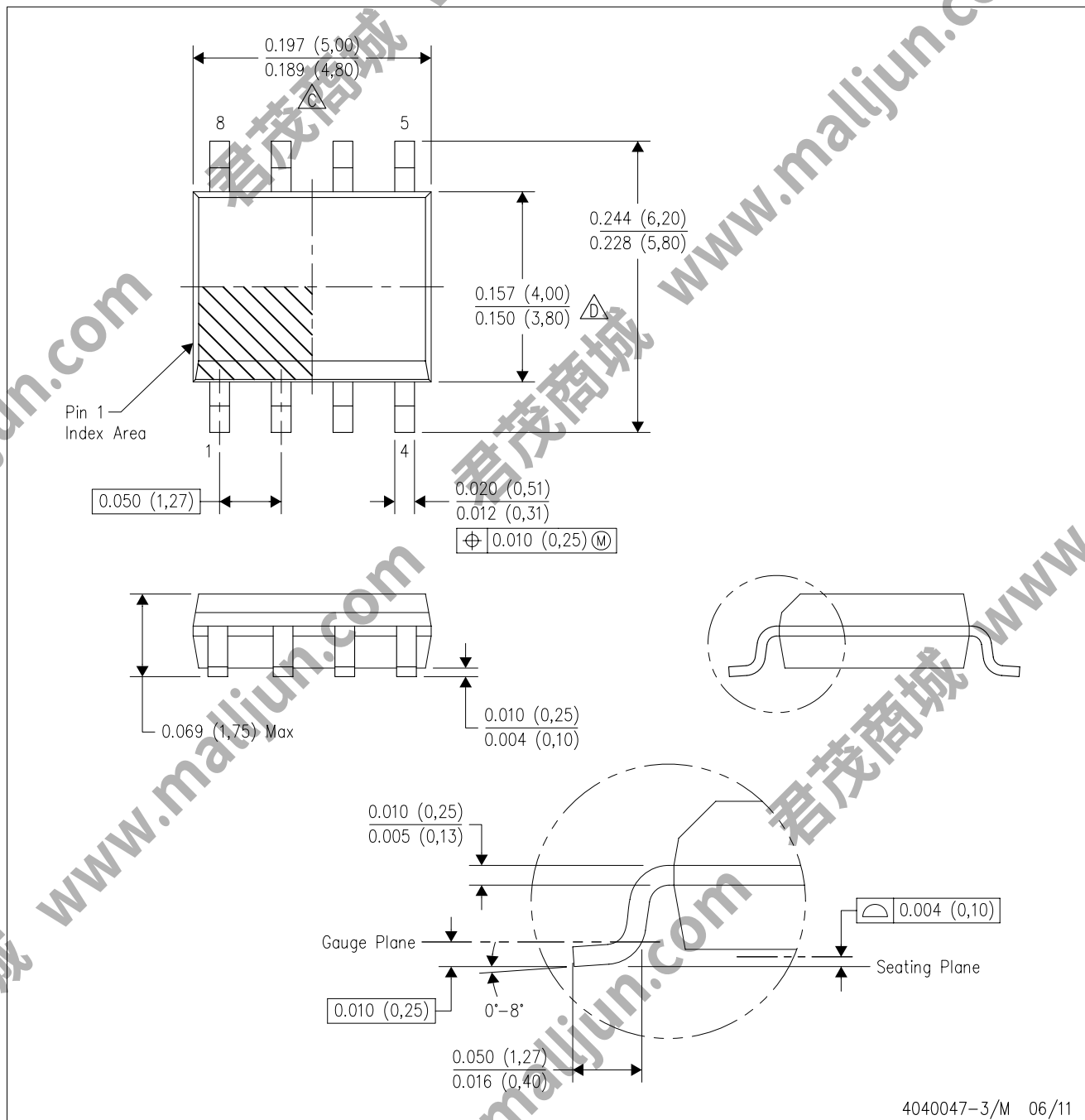
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.



TEXAS
INSTRUMENTS
www.ti.com

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE

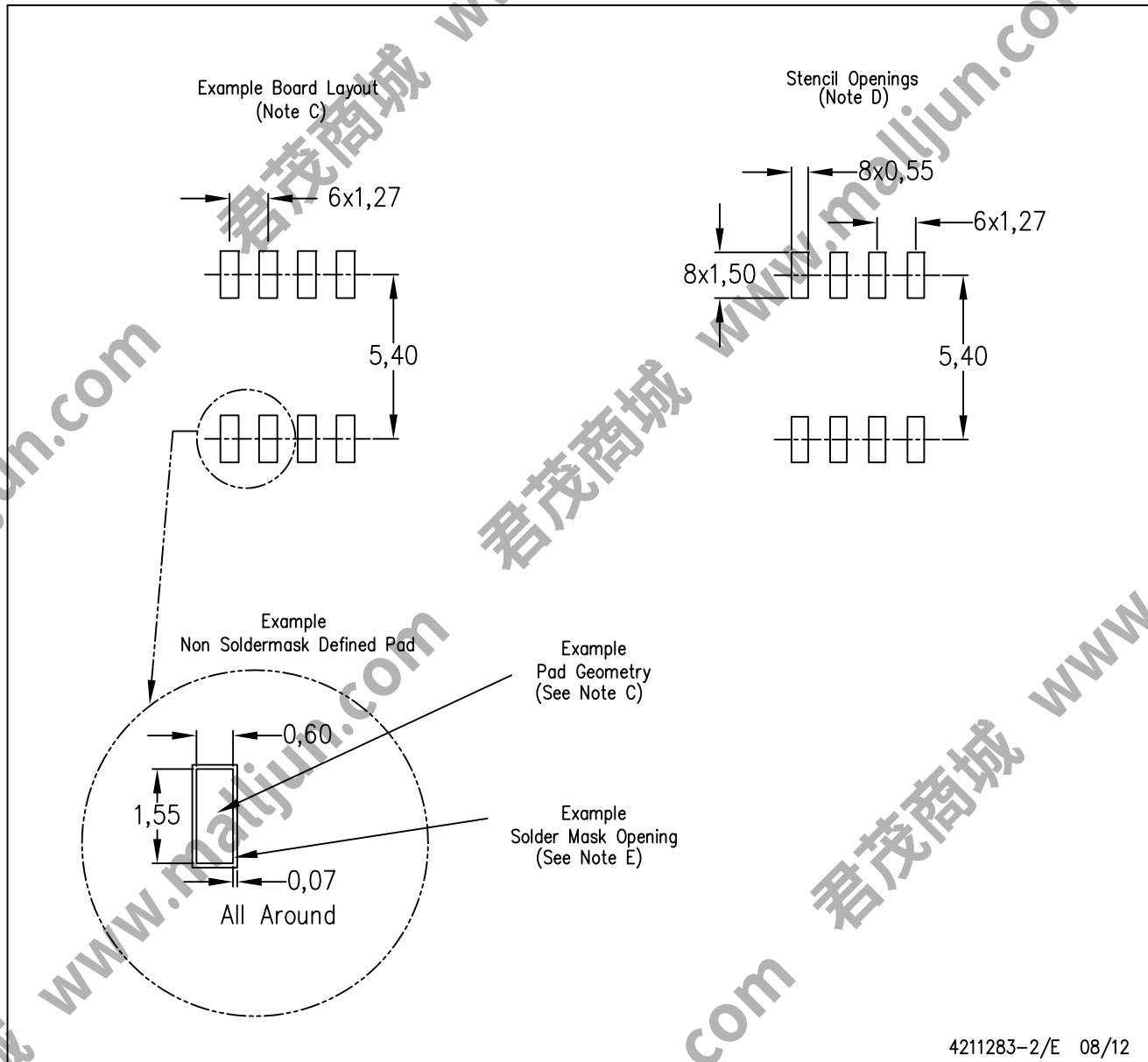


NOTES:

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

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



4211283-2/E 08/12

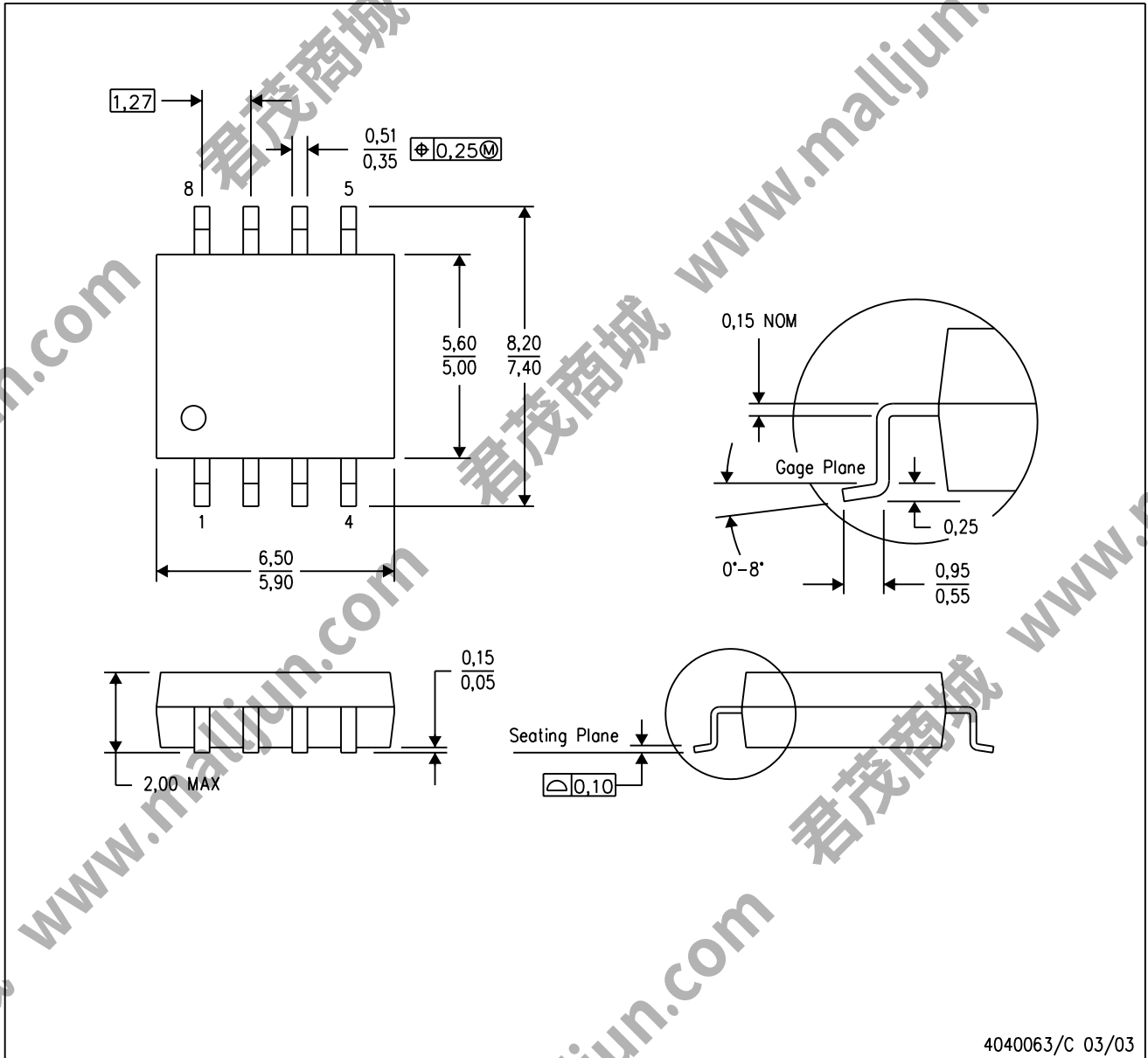
NOTES:

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

MECHANICAL DATA

PS (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE

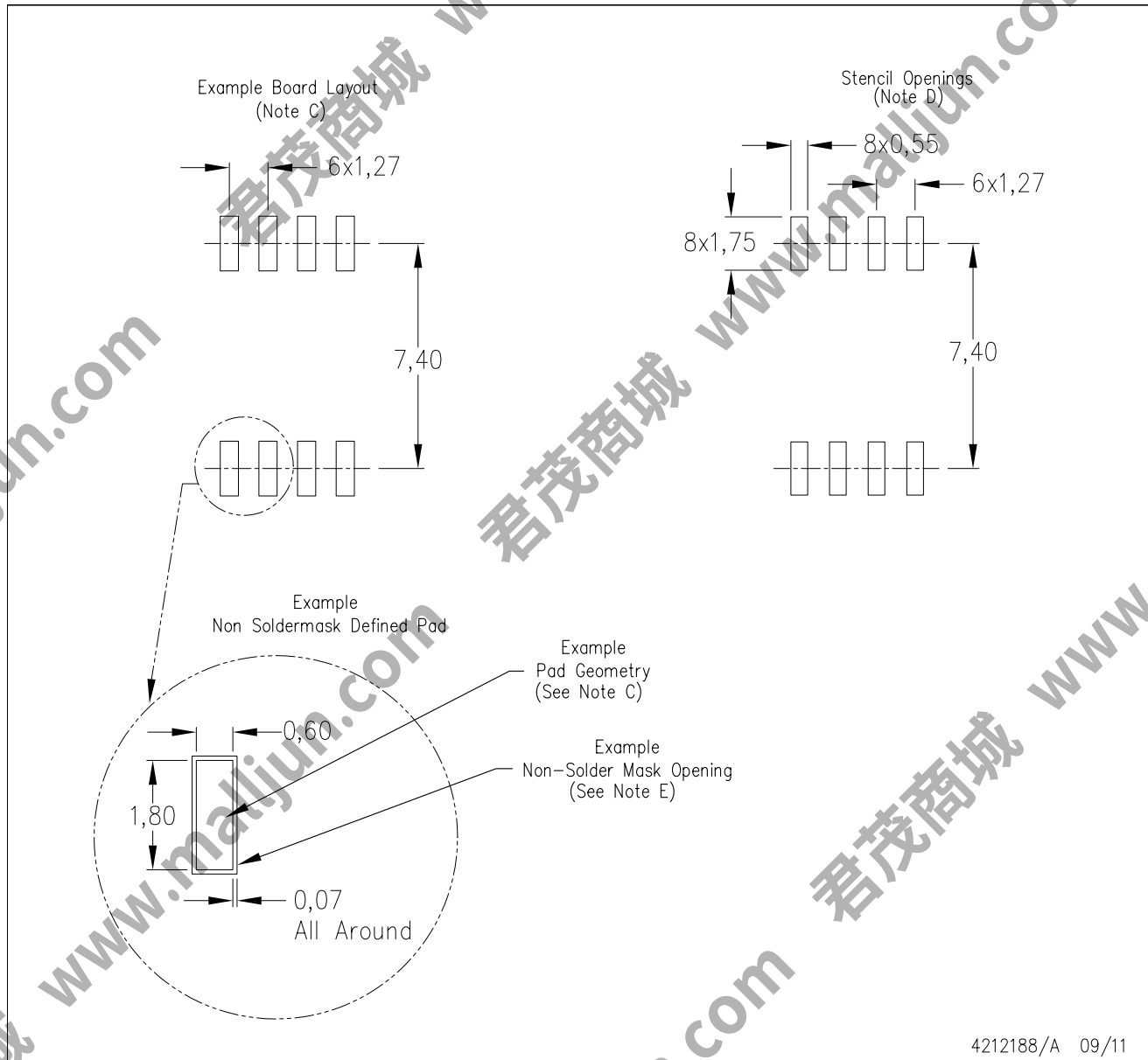


4040063/C 03/03

- 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



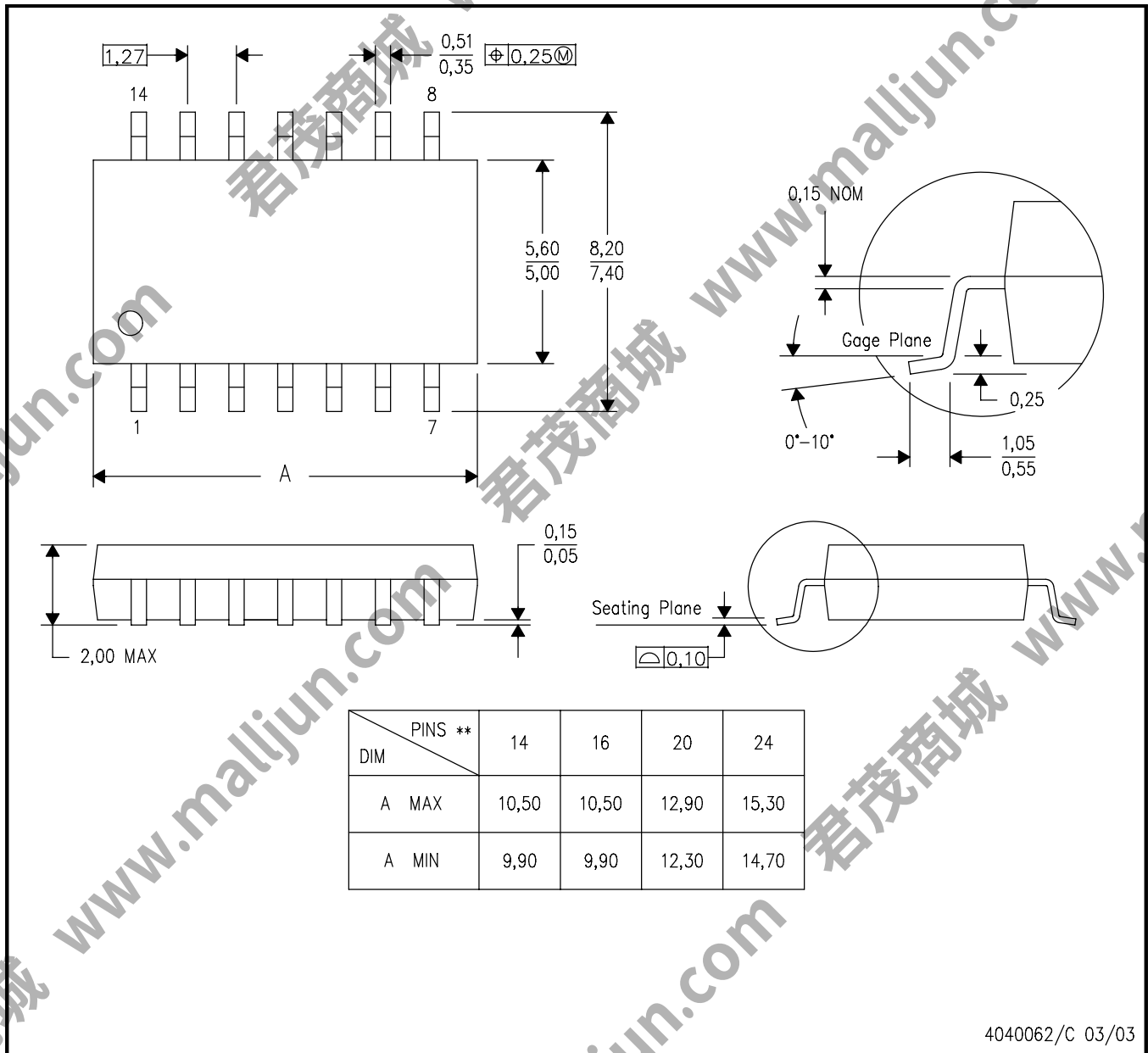
- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact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

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



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

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com