

# LM2902-Q1 QUADRUPLE OPERATIONAL AMPLIFIER

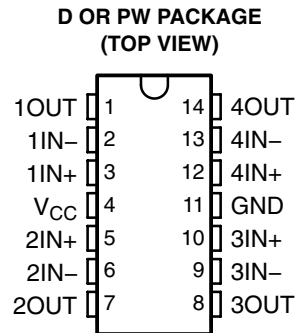
SGLS178E – AUGUST 2003 – REVISED APRIL 2008

- **Qualified for Automotive Applications**
- **ESD Protection <500 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0); 1500 V Using Charged Device Model**
- **ESD Human Body Model >2 kV Machine Model >200 V and Charge Device Model = 2 kV For K-Suffix Devices.**
- **Low Supply-Current Drain Independent of Supply Voltage . . . 0.8 mA Typ**
- **Low Input Bias and Offset Parameters:**
  - Input Offset Voltage . . . 3 mV Typ
  - Input Offset Current . . . 2 nA Typ
  - Input Bias Current . . . 20 nA Typ
- **Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground**
- **Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage:**
  - Non-V devices . . . 26 V
  - V-Suffix devices . . . 32 V
- **Open-Loop Differential Voltage Amplification . . . 100 V/mV Typ**
- **Internal Frequency Compensation**

## description/ordering information

This device consists of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies is possible when the difference between the two supplies is 3 V to 26 V (3 V to 32 V for V-suffixed devices), and  $V_{CC}$  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 more easily implemented in single-supply-voltage systems. For example, the LM2902 can be operated directly from the standard 5-V supply that is used in digital systems and easily provides the required interface electronics without requiring additional  $\pm 15$ -V supplies.



## ORDERING INFORMATION<sup>†</sup>

$T_A$	$V_{IO \text{ max}}$ AT 25°C	MAX $V_{CC}$	PACKAGE <sup>‡</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	7 mV	26 V	SOIC (D)	Reel of 2500	LM2902QDRQ1	2902Q1
			TSSOP (PW)	Reel of 2000	LM2902QPWRQ1	2902Q1
	7 mV	32 V	SOIC (D)	Reel of 2500	LM2902KVQDRQ1	2902KVQ
			TSSOP (PW)	Reel of 2000	LM2902KVQPWRQ1	2902KVQ
	2 mV	32 V	SOIC (D)	Reel of 2500	LM2902KAVQDRQ1	2902KAQ
			TSSOP (PW)	Reel of 2000	LM2902KAVQPWRQ1	2902KAQ

<sup>†</sup> For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at <http://www.ti.com>.

<sup>‡</sup> Package drawings, thermal data, and symbolization are available at <http://www.ti.com/packaging>.



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

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
INSTRUMENTS**

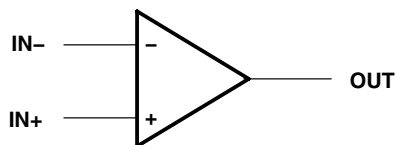
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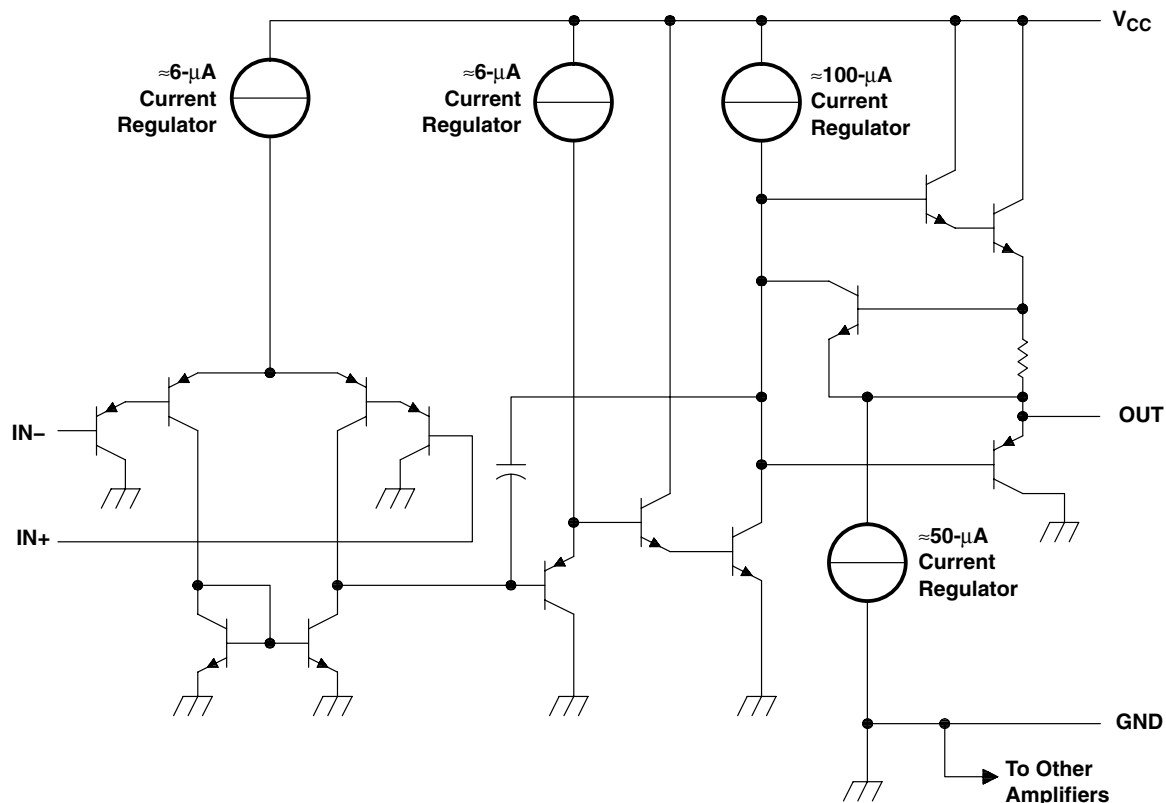
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## symbol (each amplifier)



## schematic (each amplifier)



COMPONENT COUNT (TOTAL DEVICE)	
Epi-FET	1
Transistors	95
Diodes	4
Resistors	11
Capacitors	4

# LM2902-Q1 QUADRUPLE OPERATIONAL AMPLIFIER

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## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

	LM2902-Q1	LM2902KV-Q1	UNIT
Supply voltage, $V_{CC}$ (see Note 1)	26	32	V
Differential input voltage, $V_{ID}$ (see Note 2)	$\pm 26$	$\pm 32$	V
Input voltage, $V_I$ (either input)	-0.3 to 26	-0.3 to 32	V
Duration of output short circuit (one amplifier) to ground at (or below) $T_A = 25^\circ\text{C}$ , $V_{CC} \leq 15\text{ V}$ (see Note 3)	Unlimited	Unlimited	
Package thermal impedance, $\theta_{JA}$ (see Notes 4 and 5)	D package (0 LFPM)	101	$^\circ\text{C/W}$
	PW package	113	
Operating virtual junction temperature, $T_J$	142	142	$^\circ\text{C}$
Storage temperature range, $T_{stg}$	-65 to 150	-65 to 150	$^\circ\text{C}$

† 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.

- NOTES:
1. All voltage values, except differential voltages and  $V_{CC}$  specified for the measurement of  $I_{OS}$ , are with respect to the network GND.
  2. Differential voltages are at  $IN+$  with respect to  $IN-$ .
  3. Short circuits from outputs to  $V_{CC}$  can cause excessive heating and eventual destruction.
  4. Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of  $142^\circ\text{C}$  can affect reliability.
  5. The package thermal impedance is calculated in accordance with JESD 51-7.

# LM2902-Q1

## QUADRUPLE OPERATIONAL AMPLIFIER

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### electrical characteristics at specified free-air temperature, $V_{CC} = 5\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	$T_A$ ‡	LM2902-Q1			UNIT
			MIN	TYP§	MAX	
$V_{IO}$ Input offset voltage	$V_{CC} = 5\text{ V to } 26\text{ V}$ , $V_{IC} = V_{ICRmin}$ , $V_O = 1.4\text{ V}$	25°C	3	7		mV
		Full range			10	
$I_{IO}$ Input offset current	$V_O = 1.4\text{ V}$	25°C	2	50		nA
		Full range			300	
$I_{IB}$ Input bias current	$V_O = 1.4\text{ V}$	25°C	-20	-250		nA
		Full range			-500	
$V_{ICR}$ Common-mode input voltage range	$V_{CC} = 5\text{ V to } 26\text{ V}$	25°C	0 to $V_{CC} - 1.5$			V
		Full range	0 to $V_{CC} - 2$			
$V_{OH}$ High-level output voltage	$R_L = 10\text{ k}\Omega$	25°C	$V_{CC} - 1.5$			V
	$V_{CC} = 26\text{ V}$ , $R_L = 2\text{ k}\Omega$	Full range	22			
	$V_{CC} = 26\text{ V}$ , $R_L \geq 10\text{ k}\Omega$	Full range	23	24		
$V_{OL}$ Low-level output voltage	$R_L \leq 10\text{ k}\Omega$	Full range	5	20		mV
$A_{VD}$ Large-signal differential voltage amplification	$V_{CC} = 15\text{ V}$ , $V_O = 1\text{ V to } 11\text{ V}$ , $R_L \geq 2\text{ k}\Omega$	25°C	100			V/mV
		Full range	15			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C	50	80		dB
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC}/\Delta V_{IO}$ )		25°C	50	100		dB
$V_{O1}/V_{O2}$ Crosstalk attenuation	$f = 1\text{ kHz to } 20\text{ kHz}$	25°C	120			dB
$I_O$ Output current	$V_{CC} = 15\text{ V}$ , $V_{ID} = 1\text{ V}$ , $V_O = 0$	25°C	-20	-30	-60	mA
		Full range	-10			
	$V_{CC} = 15\text{ V}$ , $V_{ID} = -1\text{ V}$ , $V_O = 15\text{ V}$	25°C	10	20		
		Full range	5			
$V_{ID} = -1\text{ V}$ , $V_O = 200\text{ mV}$	25°C	30			$\mu\text{A}$	
$I_{OS}$ Short-circuit output current	$V_{CC}$ at 5 V, $V_O = 0$ , GND at -5 V	25°C	$\pm 40$	$\pm 60$		mA
$I_{CC}$ Supply current (four amplifiers)	$V_O = 2.5\text{ V}$ , No load	Full range	0.7	1.2		mA
	$V_{CC} = 26\text{ V}$ , $V_O = 0.5 V_{CC}$ , No load	Full range	1.4	3		

† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.

‡ Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

§ All typical values are at  $T_A = 25^\circ\text{C}$ .



# LM2902-Q1 QUADRUPLE OPERATIONAL AMPLIFIER

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**electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)  
(continued)**

PARAMETER	TEST CONDITIONS†		$T_A$ ‡	LM2902KV-Q1			UNIT
				MIN	TYP§	MAX	
$V_{IO}$ Input offset voltage	$V_{CC} = 5\text{ V to }32\text{ V}$ , $V_{IC} = V_{ICRmin}$ , $V_O = 1.4\text{ V}$	Non-A devices	25°C	3	7	mV	
			Full range	10			
		A-suffix devices	25°C	1	2		
			Full range	4			
$\Delta V_{IO}/\Delta T$ Temperature drift	$R_S = 0\ \Omega$	Full range	7		$\mu\text{V}/^\circ\text{C}$		
$I_{IO}$ Input offset current	$V_O = 1.4\text{ V}$	25°C	2	50	nA		
		Full range	150				
$\Delta I_{IO}/\Delta T$ Temperature drift		Full range	10		$\text{pA}/^\circ\text{C}$		
$I_{IB}$ Input bias current	$V_O = 1.4\text{ V}$	25°C	-20	-250	nA		
		Full range	-500				
$V_{ICR}$ Common-mode input voltage range	$V_{CC} = 5\text{ V to }32\text{ V}$	25°C	0 to $V_{CC} - 1.5$		V		
		Full range	0 to $V_{CC} - 2$				
$V_{OH}$ High-level output voltage	$R_L = 10\text{ k}\Omega$	25°C	$V_{CC} - 1.5$		V		
	$V_{CC} = 32\text{ V}$ , $R_L = 2\text{ k}\Omega$	Full range	26				
	$V_{CC} = 32\text{ V}$ , $R_L \geq 10\text{ k}\Omega$	Full range	27				
$V_{OL}$ Low-level output voltage	$R_L \leq 10\text{ k}\Omega$	Full range	5	20	mV		
$A_{VD}$ Large-signal differential voltage amplification	$V_{CC} = 15\text{ V}$ , $V_O = 1\text{ V to }11\text{ V}$ , $R_L \geq 2\text{ k}\Omega$	25°C	25	100	V/mV		
		Full range	15				
Amplifier-to-amplifier coupling¶	$f = 1\text{ kHz to }20\text{ kHz}$ , input referred	25°C	120		dB		
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C	60	80	dB		
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC}/\Delta V_{IO}$ )		25°C	60	100	dB		
$V_{O1}/V_{O2}$ Crosstalk attenuation	$f = 1\text{ kHz to }20\text{ kHz}$	25°C	120		dB		
$I_O$ Output current	$V_{CC} = 15$ $V_O = 0$	$V_{ID} = 1\text{ V}$	25°C	-20	-30	-60	mA
			Full range	-10			
	$V_{CC} = 15$ $V_O = 15\text{ V}$	$V_{ID} = -1\text{ V}$	25°C	10	20		
			Full range	5			
	$V_{ID} = -1\text{ V}$ , $V_O = 200\text{ mV}$	25°C	12	40	$\mu\text{A}$		
$I_{OS}$ Short-circuit output current	$V_{CC}$ at 5 V, GND at -5 V	$V_O = 0$ ,	25°C	$\pm 40$	$\pm 60$	mA	
$I_{CC}$ Supply current (four amplifiers)	$V_O = 2.5\text{ V}$ , $V_{CC} = 32\text{ V}$	No load	Full range	0.7	1.2	mA	
	$V_O = 0.5 V_{CC}$ ,	No load	Full range	1.4	3		

† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.

‡ Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

§ All typical values are at  $T_A = 25^\circ\text{C}$ .

¶ Due to proximity of external components, ensure that coupling is not originating via stray capacitance between these external parts. Typically, this can be detected, as this type of coupling increases at higher frequencies.



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

PARAMETER		TEST CONDITIONS	TYP	UNIT
SR	Slew rate at unity gain	$R_L = 1\text{ M}\Omega$ , $C_L = 30\text{ pF}$ , $V_I = \pm 10\text{ V}$ (see Figure 1)	0.5	$\text{V}/\mu\text{s}$
$B_1$	Unity-gain bandwidth	$R_L = 1\text{ M}\Omega$ , $C_L = 20\text{ pF}$ (see Figure 1)	1.2	MHz
$V_n$	Equivalent input noise voltage	$R_S = 100\ \Omega$ , $V_I = 0\text{ V}$ , $f = 1\text{ kHz}$ (see Figure 2)	35	$\text{nV}/\sqrt{\text{Hz}}$

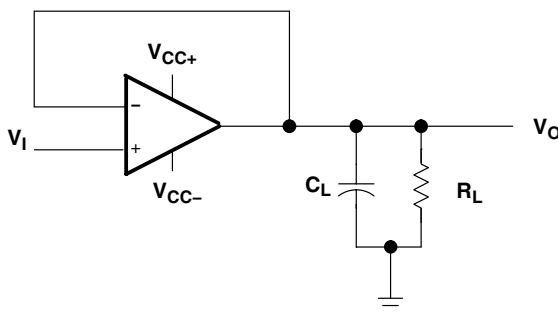


Figure 1. Unity-Gain Amplifier

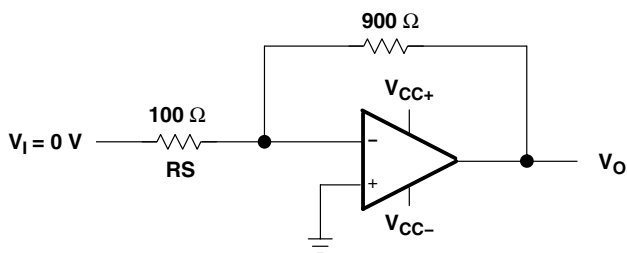


Figure 2. Noise-Test Circuit

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/ Ball Finish	MSL Peak Temp <sup>(3)</sup>	Samples (Requires Login)
LM2902KAVQDRG4Q1	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LM2902KAVQDRQ1	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LM2902KAVQPWRG4Q1	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LM2902KAVQPWRQ1	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LM2902KVQDRG4Q1	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LM2902KVQDRQ1	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LM2902KVQPWRG4Q1	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LM2902KVQPWRQ1	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LM2902QDRG4Q1	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LM2902QDRQ1	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LM2902QPWRG4Q1	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LM2902QPWRQ1	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

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

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

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

**OBSOLETE:** TI has discontinued the production of the device.

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

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

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

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

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

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

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**OTHER QUALIFIED VERSIONS OF LM2902-Q1 :**

- Catalog: [LM2902](#)
- Enhanced Product: [LM2902-EP](#)

NOTE: Qualified Version Definitions:

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



D (R-PDSO-G14)

PLASTIC SMALL OUTLINE

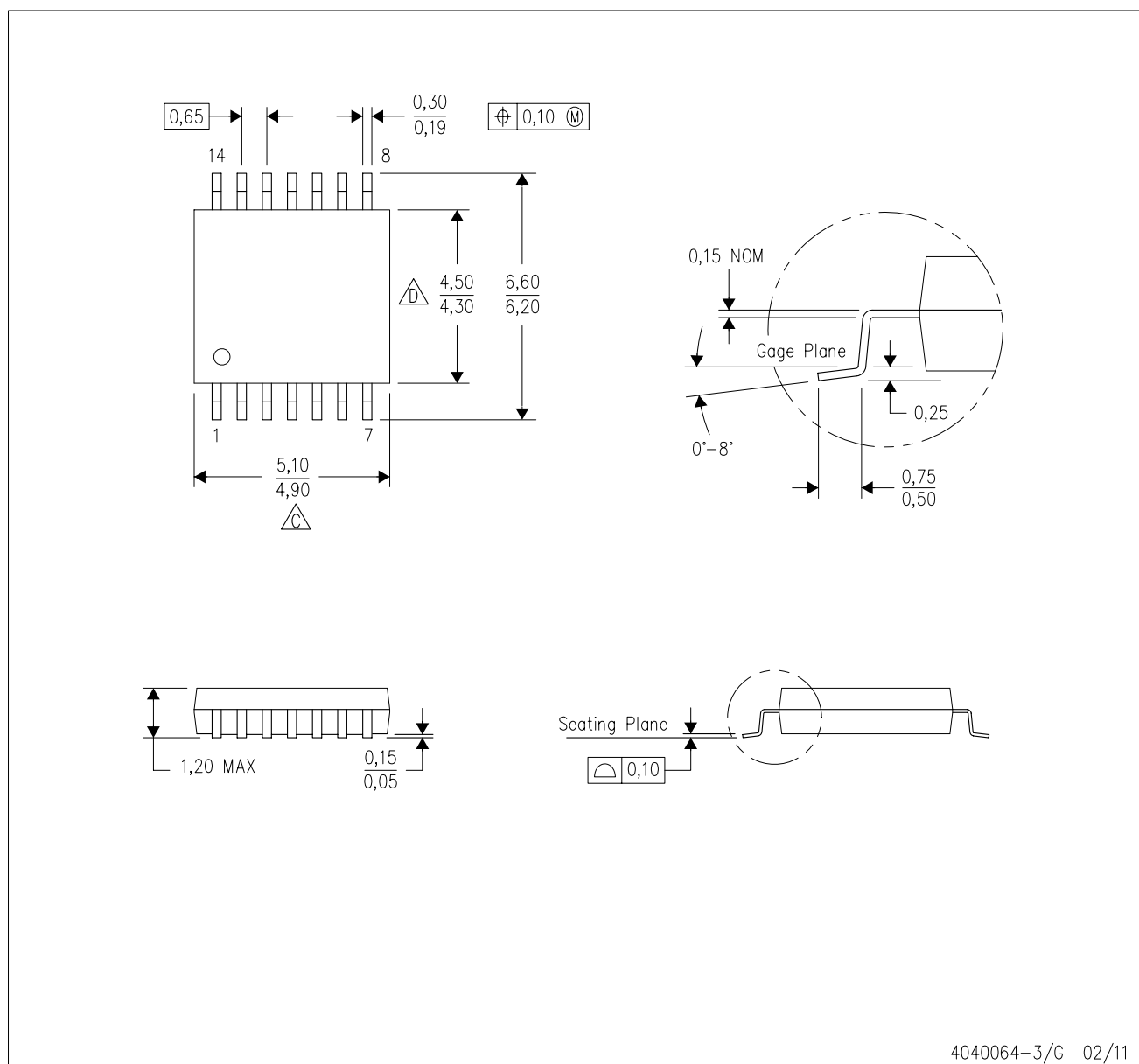


4040047-5/M 06/11

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  -  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.
  -  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.

PW (R-PDSO-G14)

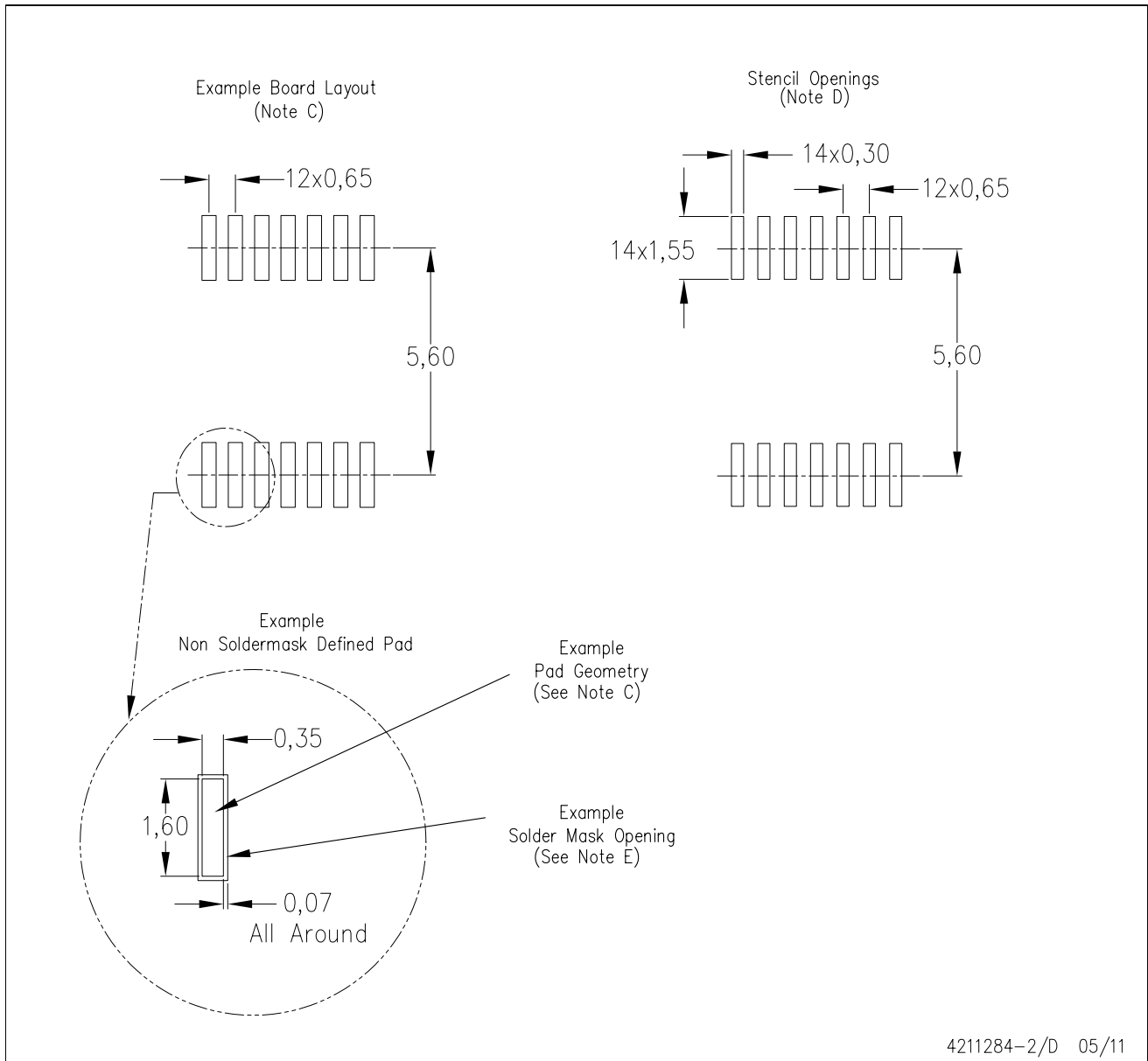
PLASTIC SMALL OUTLINE



- 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.  
 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.  
 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.

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Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Mobile Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
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