

SBOS247B - JUNE 2002 - REVISED FEBRUARY 2005

Low-Noise, Low-Distortion INSTRUMENTATION AMPLIFIER Replacement for SSM2017

FEATURES

● LOW NOISE: 1.3nV/√Hz at 1kHz

LOW THD+N: 0.004% at 1kHz, G = 100
 WIDE BANDWIDTH: 800kHz at G = 100
 WIDE SUPPLY RANGE: ±4.5V to ±18V

● HIGH CMR: > 100dB

• GAIN SET WITH EXTERNAL RESISTOR

DIP-8 AND SOL-16 WIDEBODY PACKAGES

APPLICATIONS

- PROFESSIONAL MICROPHONE PREAMPS
- MOVING-COIL TRANSDUCER AMPLIFIERS
- DIFFERENTIAL RECEIVERS
- BRIDGE TRANSDUCER AMPLIFIERS

$V_{\text{IN}} = 0$ $V_{\text{IN}} =$

DESCRIPTION

The INA217 is a low-noise, low-distortion, monolithic instrumentation amplifier. Current-feedback circuitry allows the INA217 to achieve wide bandwidth and excellent dynamic response over a wide range of gain. The INA217 is ideal for low-level audio signals such as balanced low-impedance microphones. Many industrial, instrumentation, and medical applications also benefit from its low noise and wide bandwidth.

Unique distortion cancellation circuitry reduces distortion to extremely low levels, even in high gain. The INA217 provides near-theoretical noise performance for 200Ω source impedance. The INA217 features differential input, low noise, and low distortion that provides superior performance in professional microphone amplifier applications.

The INA217 features wide supply voltage, excellent output voltage swing, and high output current drive, making it an optimal candidate for use in high-level audio stages.

The INA217 is available in the same DIP-8 and SOL-16 wide body packages and pinouts as the SSM2017. For a smaller package, see the INA163 in SO-14 narrow. The INA217 is specified over the temperature range of -40°C to +85°C.



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.

All trademarks are the property of their respective owners.



ABSOLUTE MAXIMUM RATINGS(1)

Supply Voltage, V+ to V	±18V
Signal Input Terminals, Voltage(2)	(V-) - 0.5V to $(V+) + 0.5V$
Current ⁽²⁾	10mA
Output Short-Circuit(3)	Continuous
Operating Temperature	55°C to +125°C
Storage Temperature	55°C to +150°C
Junction Temperature	+150°C
Lead Temperature (soldering, 10s)	+300°C

NOTES: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. (2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current limited to 10mA or less. (3) Short-circuit to ground, one amplifier per package.

PACKAGE/ORDERING INFORMATION(1)

PRODUCT	PACKAGE-LEAD	PACKAGE DESIGNATOR	PACKAGE MARKING
INA217	SOL-16	DW	INA217
INA217	DIP-8	Р	INA217

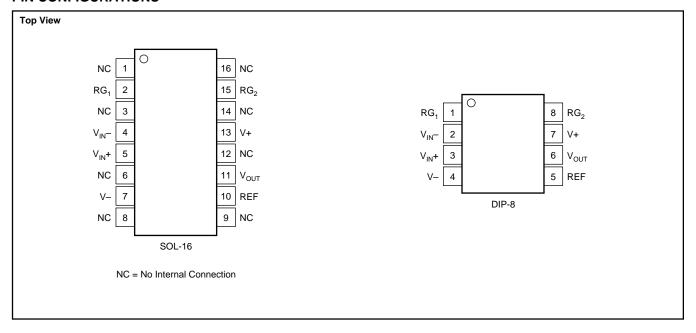
NOTES: (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

ELECTROSTATIC DISCHARGE SENSITIVITY

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.

PIN CONFIGURATIONS



ELECTRICAL CHARACTERISTICS: $V_S = \pm 15V$

Boldface limits apply over the specified temperature range, $T_A = -40^{\circ}C$ to $+85^{\circ}C$.

 $\rm T_A$ = +25°C, $\rm R_L$ = 2k $\Omega,~\rm V_S$ = ±15V, unless otherwise noted.

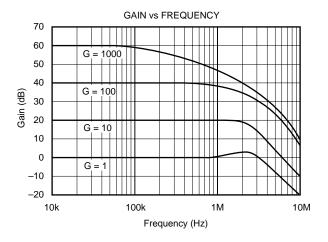
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	
GAIN EQUATION			$G = 1 + 10k/R_G$			
Range			1 to 10000		V/V	
Gain Error, G = 1			±0.1	±0.25	%	
G = 10			±0.2	±0.7	%	
G = 100			±0.2		%	
G = 1000			±0.5		%	
Gain Temp Drift Coefficient, G = 1			±3	±10	ppm/°C	
G > 10			±40	±100	ppm/°C	
Nonlinearity, G = 1			±0.0003	±100	% of FS	
G = 100			±0.0006		% of FS	
INPUT STAGE NOISE						
Voltage Noise	$R_{SOURCE} = 0\Omega$					
$f_O = 1kHz$	000,102		1.3		nV/√Hz	
f _O = 100Hz			1.5		nV/√Hz	
f _O = 10Hz			3.5		nV/√Hz	
Current Noise			0.0		,	
f _O = 1kHz			0.8		pA/√Hz	
OUTPUT STAGE NOISE					· · · · · · · · · · · · · · · · · · ·	
Voltage Noise, f _O = 1kHz			90		nV/√Hz	
INPUT OFFSET VOLTAGE						
Input Offset Voltage	$V_{CM} = V_{OUT} = 0V$		50 + 2000/G	250 + 5000/G	μV	
vs Temperature	$T_A = T_{MIN}$ to T_{MAX}		1 + 20/G		μ V/°C	
vs Power Supply	$V_{S} = \pm 4.5 \text{V to } \pm 18 \text{V}$		1 + 50/G	3 + 200/G	μV/V	
INPUT VOLTAGE RANGE	-					
Common-Mode Voltage Range	$V_{IN} + - V_{IN} - = 0V$	(V+) - 4	(V+) - 3		V	
Common mode vonage range	$V_{IN} + -V_{IN} - = 0V$	(V-) + 4	(V-) + 3		V	
Common-Mode Rejection, G = 1	$V_{CM} = \pm 11V, R_{SRC} = 0\Omega$	70	80		dB	
G = 100	V _{CM} = ±11V, N _{SRC} = 032	100	116		dB	
		100	110		QD.	
INPUT BIAS CURRENT						
Initial Bias Current			2	12	μΑ	
vs Temperature			10		nA/°C	
Initial Offset Current			0.1	1	μΑ	
vs Temperature			0.5		nA/°C	
INPUT IMPEDANCE						
	Differential		60 2		MΩ pF	
	Common-Mode		60 2		MΩ pF	
DYNAMIC RESPONSE						
Bandwidth, Small Signal, -3dB, G = 1			3.4		MHz	
G = 100			800		kHz	
Slew Rate			15		V/μs	
THD+Noise, f = 1kHz	G = 100		0.004		%	
Settling Time, 0.1%	G = 100, 10V Step		2		μs	
0.01%	G = 100, 10V Step		3.5		μs	
Overload Recovery	50% Overdrive		1		μs	
ОИТРИТ						
Voltage	R _L to GND	(V+) - 2	(V+) - 1.8		V	
		(V–) + 2	(V-) + 1.8		V	
Load Capacitance Stability		l ' '	1000		pF	
Short-Circuit Current	Continuous-to-Common		±60		mA	
POWER SUPPLY						
Rated Voltage			±15		V	
Voltage Range		±4.5	_ 10	±18	V	
	I _O = 0mA	14.5	±10	±12	mA	
Current, Quiescent		ļ				
Current, Quiescent TEMPERATURE RANGE						
TEMPERATURE RANGE		–40		+85	°C	
TEMPERATURE RANGE Specification		-40 -40		+85 +125	°C °C	
TEMPERATURE RANGE Specification Operating		-40 -40		+85 +125	°C °C	
TEMPERATURE RANGE Specification			+85			

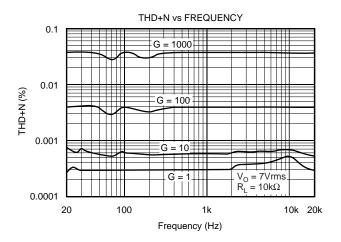
NOTE: (1) Gain accuracy is a function of external R_G.

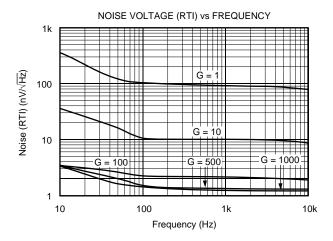


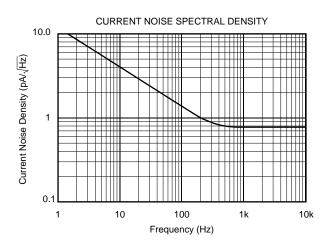
TYPICAL CHARACTERISTICS

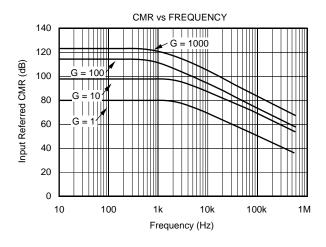
At T_A = +25°C, V_S = ±15V, R_L = 2k Ω , unless otherwise noted.

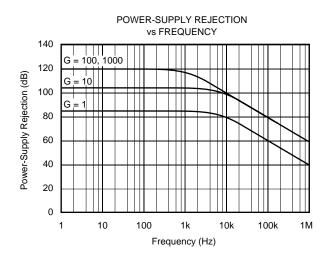








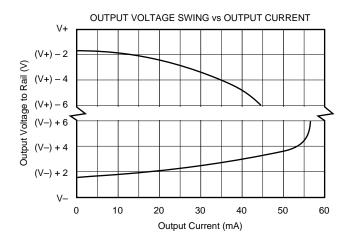


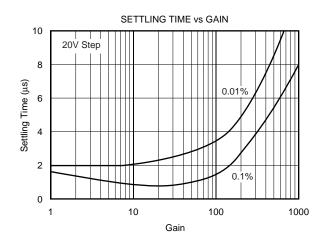


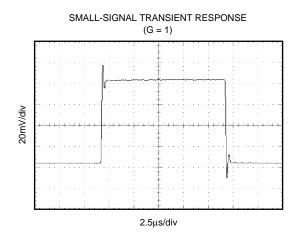


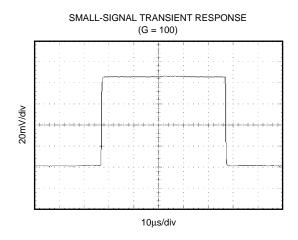
TYPICAL CHARACTERISTICS (Cont.)

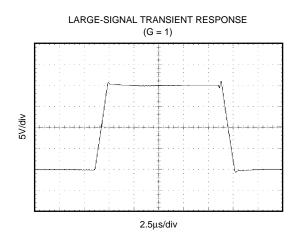
At T_A = +25°C, V_S = ±15V, R_L = 2k Ω , unless otherwise noted.

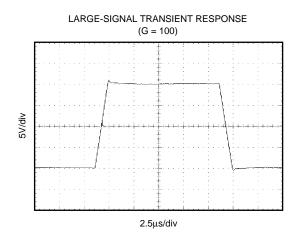














APPLICATIONS INFORMATION

Figure 1 shows the basic connections required for operation. Power supplies should be bypassed with $0.1\mu F$ tantalum capacitors near the device pins. The output Reference (pin 5) should be a low-impedance connection. Resistance of a few ohms in series with this connection will degrade the common-mode rejection of the INA217.

GAIN-SET RESISTOR

Gain is set with an external resistor, R_G , as shown in Figure 1. The two internal $5k\Omega$ feedback resistors are laser-trimmed to $5k\Omega$ within approximately $\pm 0.2\%$. The gain equation for the INA217 is:

$$G = 1 + \frac{10,000}{R_G}$$

The temperature coefficient of the internal $5k\Omega$ resistors is approximately $\pm 25 ppm/^{\circ}C$. Accuracy and TCR of the external R_G will also contribute to gain error and temperature drift. These effects can be inferred from the gain equation. Make a short, direct connection to the gain set resistor, R_G . Avoid running output signals near these sensitive input nodes.

NOISE PERFORMANCE

The INA217 provides very low noise with low-source impedance. Its $1.3 \text{nV}/\sqrt{\text{Hz}}$ voltage noise delivers near-theoretical noise performance with a source impedance of 200Ω . The input stage design used to achieve this low noise results in

relatively high input bias current and input bias current noise. As a result, the INA217 may not provide the best noise performance with a source impedance greater than $10k\Omega$. For source impedance greater than $10k\Omega$, other instrumentation amplifiers may provide improved noise performance.

INPUT CONSIDERATIONS

Very low source impedance (less than 10Ω) can cause the INA217 to oscillate. This depends on circuit layout, signal source, and input cable characteristics. An input network consisting of a small inductor and resistor, as shown in Figure 2, can greatly reduce any tendency to oscillate. This is especially useful if a variety of input sources are to be connected to the INA217. Although not shown in other figures, this network can be used as needed with all applications shown.

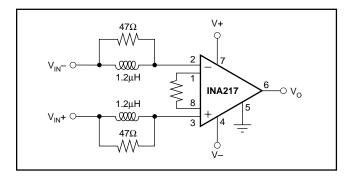


FIGURE 2. Input Stabilization Network.

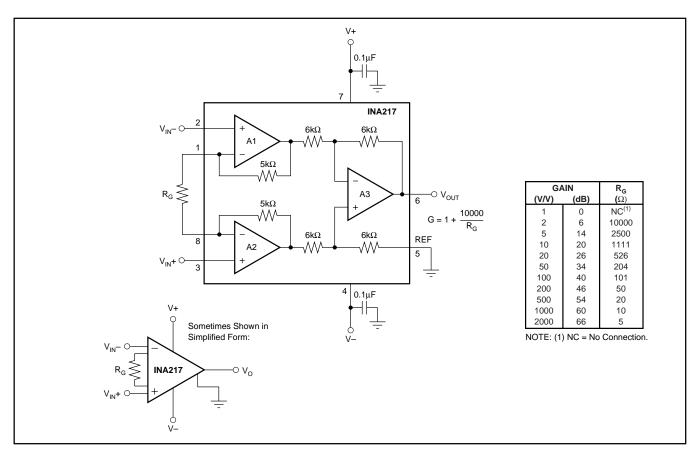


FIGURE 1. Basic Circuit Connections.



OFFSET VOLTAGE TRIM

A variable voltage applied to pin 5, as shown in Figure 3, can be used to adjust the output offset voltage. A voltage applied to pin 5 is summed with the output signal. An op amp connected as a buffer is used to provide a low impedance at pin 5 to assure good common-mode rejection.

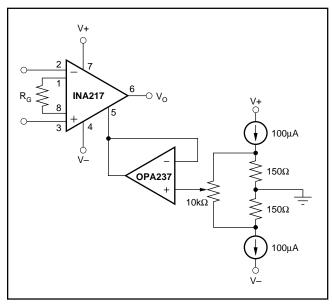


FIGURE 3. Offset Voltage Adjustment Circuit.

MICROPHONE AMPLIFIER

Figure 4 shows a typical circuit for a professional microphone input amplifier. R_1 and R_2 provide a current path for conventional 48V phantom power source for a remotely located microphone. An optional switch allows phantom power to be disabled. C_1 and C_2 block the phantom power voltage from the INA217 input circuitry. Non-polarized capacitors should be used for C_1 and C_2 if phantom power is to be disabled. For additional input protection against ESD and hot-plugging, four IN4148 diodes may be connected from the input to supply lines.

 $\rm R_4$ and $\rm R_5$ provide a path for input bias current of the INA217. Input offset current (typically 100nA) creates a DC differential input voltage that will produce an output offset voltage. This is generally the dominant source of output offset voltage in this application. With a maximum gain of 1000 (60dB), the output offset voltage can be several volts. This may be entirely acceptable if the output is AC-coupled into the subsequent stage. An alternate technique is shown in Figure 4. An inexpensive FET-input op amp in a feedback loop drives the DC output voltage to 0V. A2 is not in the audio signal path and does not affect signal quality.

Gain is set with a variable resistor, R_7 , in series with R_6 . R_6 determines the maximum gain. The total resistance, $R_6 + R_7$, determines the lowest gain. A special reverse-log taper potentiometer for R_7 can be used to create a linear change (in dB) with rotation.

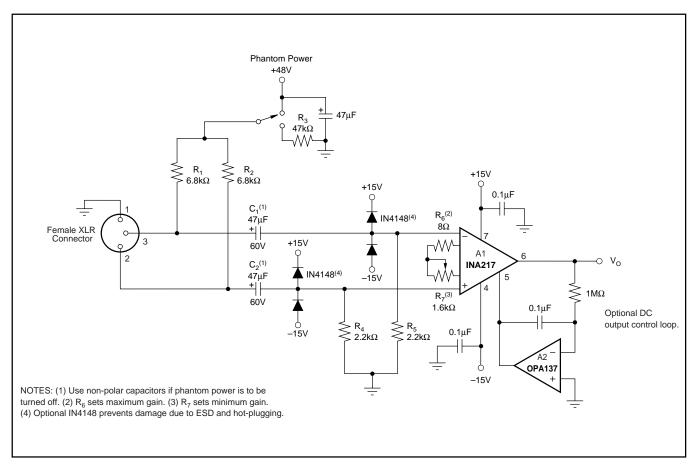


FIGURE 4. Phantom-Powered Microphone Preamplifier.







www.ti.com 6-Jan-2012

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/ Ball Finish	MSL Peak Temp ⁽³⁾	Samples (Requires Login)
INA217AIDWR	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	
INA217AIDWRE4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	
INA217AIDWT	ACTIVE	SOIC	DW	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	
INA217AIDWTE4	ACTIVE	SOIC	DW	16	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	
INA217AIP	ACTIVE	PDIP	Р	8	50	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	
INA217AIPG4	ACTIVE	PDIP	Р	8	50	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	

(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) 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.

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.



PACKAGE OPTION ADDENDUM

6-Jan-2012

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.

PACKAGE MATERIALS INFORMATION

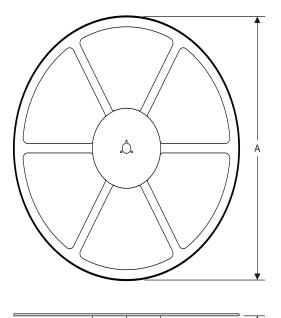
www.ti.com 6-Jun-2012

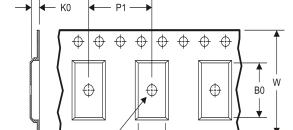
TAPE DIMENSIONS

Cavity

TAPE AND REEL INFORMATION

REEL DIMENSIONS





◆ A0 **▶**

A0	Dimension designed to accommodate the component width
В0	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



TAPE AND REEL INFORMATION

*All dimensions are nominal

Device	Package Type	Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
INA217AIDWR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
INA217AIDWT	SOIC	DW	16	250	180.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1

PACKAGE MATERIALS INFORMATION

www.ti.com 6-Jun-2012



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
INA217AIDWR	SOIC	DW	16	2000	346.0	346.0	33.0
INA217AIDWT	SOIC	DW	16	250	184.0	184.0	50.0

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.



DW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



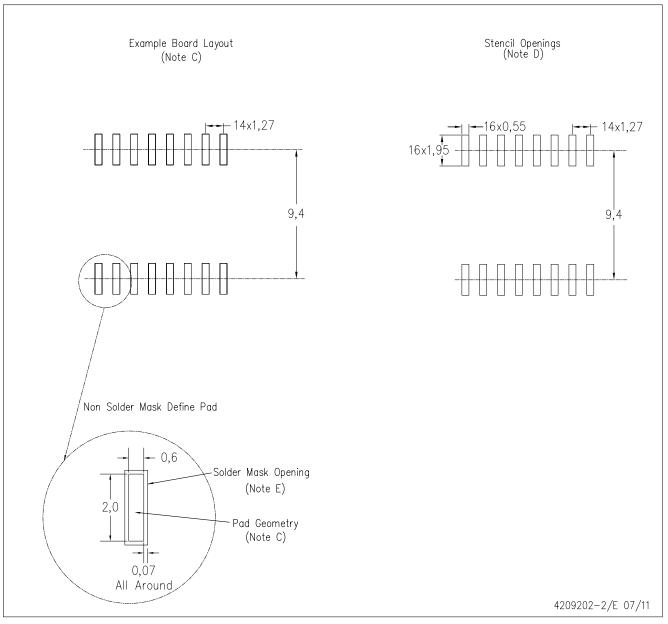
NOTES: A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.

- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
- D. Falls within JEDEC MS-013 variation AA.



DW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



NOTES:

- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Refer to IPC7351 for alternate board design.
- 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
- E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.



IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI 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 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. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

Applications

Automotive and Transportation www.ti.com/automotive

e2e.ti.com

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

		•	
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video

RFID <u>www.ti-rfid.com</u>
OMAP Mobile Processors www.ti.com/omap

Products

Audio

Wireless Connectivity www.ti.com/wirelessconnectivity

www.ti.com/audio

TI E2E Community Home Page

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265 Copyright © 2012, Texas Instruments Incorporated