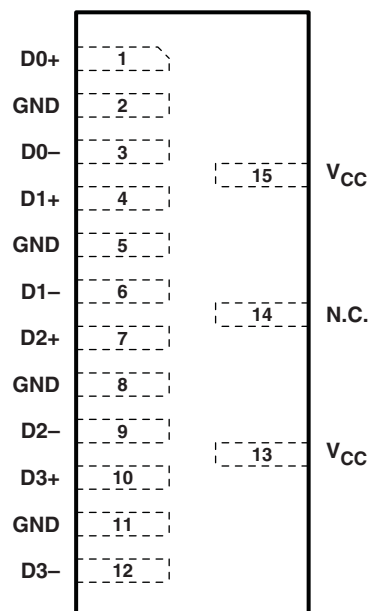


## 8-CHANNEL DISPLAY/HDMI PORT ESD PROTECTION

### FEATURES

- Supports High-Definition Multimedia Interface (HDMI) 1.3 or Display Port Data Rate
- Low 0.8-pF Line Capacitance for Each Data Line
- 0.05-pF Matching Capacitance Between Differential Signal Pair
- Four-Pair Differential Lines to Protect Differential Data and Clock Lines of HDMI and Display Port Interface
- Match With 0.5-mm Pitch Display Port Connector for Seamless Routing and Minimal Line Glitch Due to ESD Clamps
- Flow-Through Single-in-Line Pin Mapping for High-Speed Lines Ensures No Additional Board Layout Burden While Placing ESD Protection Chip Near DP/HDMI Connector
- Supports Data Rates in Excess of 2.7 Gbps
- IEC 61000-4-2 (Level 4) System Level ESD Compliance
- $I_{off}$  Feature
- Commercial Temperature Range:  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$
- 15-Pin 0.5-mm Pitch DSM Package: Length = 6.5 mm, Width = 2.5 mm, and Height = 0.8 mm

DSM PACKAGE  
(TOP VIEW)



N.C. – Not internally connected

### DESCRIPTION/ORDERING INFORMATION

The TPD8S009 provides an electrostatic discharge (ESD) solution for the display port and high-definition multimedia interface (HDMI) high-speed lines. This device offers eight ESD clamp circuits with flow-through pin mapping that matches the display port or HDMI port connector pin assignments. This device supports HDMI 1.3 or display port data rate (in excess of 3 Gbps).

The Dx+/Dx– ports add only 0.8-pF capacitance to the high-speed differential lines. In addition, the monolithic integrated circuit technology ensures that there is excellent matching between the two signal pairs of the differential line. This is a direct advantage over discrete ESD clamp solutions, where variations between two different ESD clamps may significantly degrade the differential signal quality.

The TPD8S009 complies with IEC61000-4-2 (Level 4) ESD protection. This device is offered in a space-saving SON package with 0.5-mm pitch matching the display port or HDMI connector pitch. The unique pin mapping allows the system designer to select the ESD solution at the last phase of the design without any changes in the board layout or degradation of signal-integrity performance.

The TPD8S009 is characterized for operation over the ambient air temperature range of  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .



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.

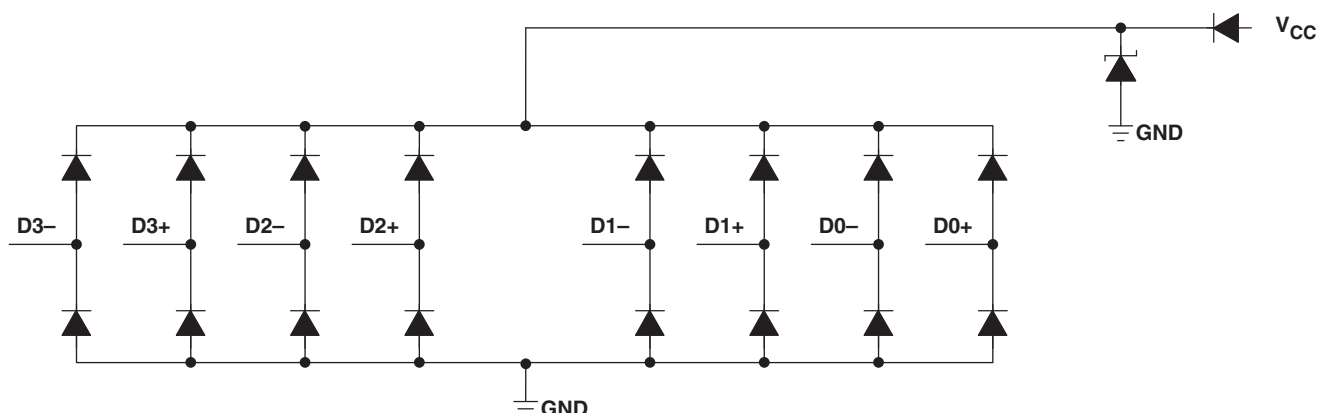
## ORDERING INFORMATION

$T_A$	PACKAGE <sup>(1)(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	SON – DSM	Tape and reel	TPD8S009DSMR	PK009

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

(2) 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](http://www.ti.com).

## BLOCK DIAGRAM



## TERMINAL FUNCTIONS

TERMINAL		TYPE	DESCRIPTION
NAME	NO.		
D0+, D0–, D1+, D1–, D2+, D2–, D3+, D3–	1, 3, 4, 6, 7, 9, 10, 12	ESD port	High-speed ESD clamp provides ESD protection to the high-speed display port/HDMI differential data lines.
GND	2, 5, 8, 11	GND	Ground
N.C.	14	No connect	No internal signal connection
V <sub>CC</sub>	13, 15	Supply	I/O supply

## ABSOLUTE MAXIMUM RATINGS

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

		MIN	MAX	UNIT
$V_{CC}$	Supply voltage range	–0.3	6	V
$V_{IO}$	IO signal voltage range	0	$V_{CC}$	V
$T_{stg}$	Storage temperature range	–65	125	°C
$T_A$	Characterized free-air operating temperature range	–40	85	°C
	Lead temperature, 1.6 mm (1/16 in) from case for 10 s		260	°C
	IEC 61000-4-2 Contact Discharge		±8	kV
	IEC 61000-4-2 Air-Gap Discharge		±9	kV
	Peak pulse power ( $t_p = 8/20 \mu s$ )		25	W
	Peak pulse current ( $t_p = 8/20 \mu s$ )		2.5	A

## ELECTRICAL CHARACTERISTICS

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

PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{RWM}$	Reverse standoff voltage	Any IO pin to ground			5.5	V
$V_{BR}$	Breakdown voltage	$I_{IO} = 1 \text{ mA}$ Any IO pin to ground	9			V
$I_{IO}$	IO port current	$V_{IO} = 3.3 \text{ V}$ , $V_{CC} = 5 \text{ V}$ Any IO pin		0.01	0.1	$\mu A$
$I_{off}$	Current from IO port to supply pins	$V_{IO} = 3.3 \text{ V}$ , $V_{CC} = 5 \text{ V}$ Any IO pin		0.01	0.1	$\mu A$
$V_D$	Diode forward voltage	$I_{IO} = 8 \text{ mA}$ Lower clamp diode	0.6	0.8	0.95	V
$R_{DYN}$	Dynamic resistance	$I = 1 \text{ A}$ Any IO pin		1.1		$\Omega$
$C_{IO}$	IO capacitance	$V_{CC} = 5 \text{ V}$ , $V_{IO} = 2.5 \text{ V}$ Any IO pin		0.8		pF
$I_{CC}$	Operating supply current	$V_{IO} = \text{Open}$ , $V_{CC} = 5 \text{ V}$ $V_{CC}$ pin		0.1	1	$\mu A$

## TYPICAL CHARACTERISTICS

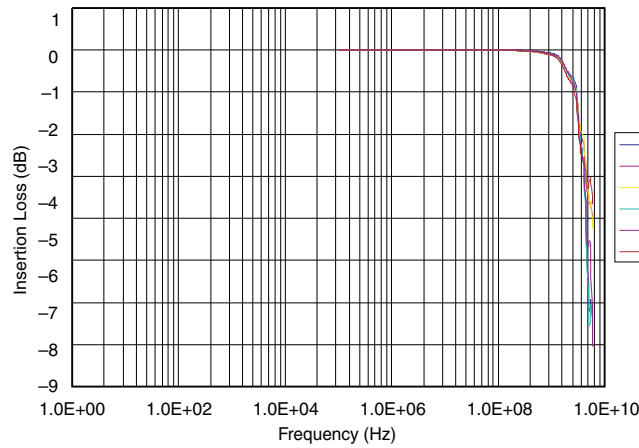


Figure 1. Insertion Loss vs Frequency

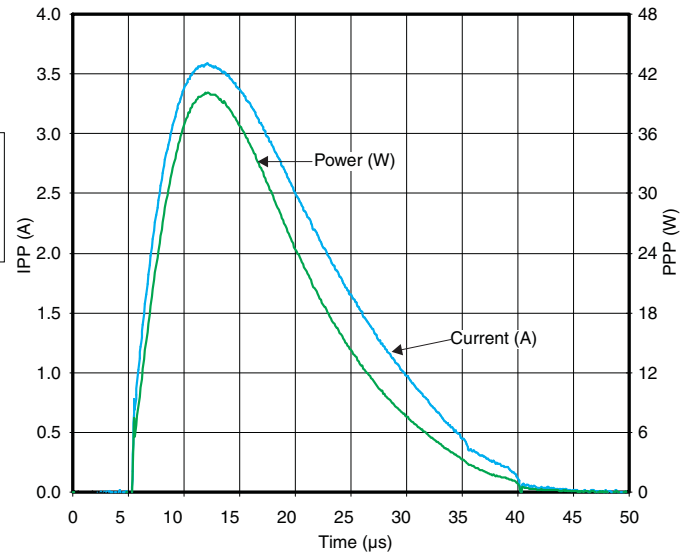


Figure 2. Peak Pulse Waveforms

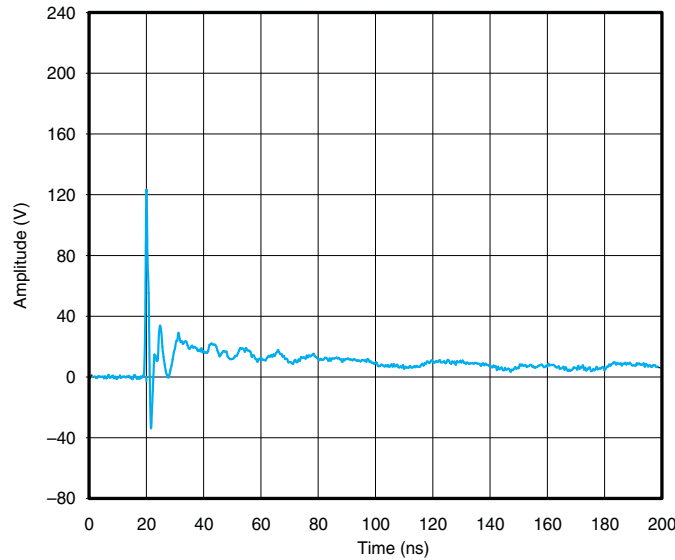


Figure 3. IEC Clamping Waveforms  
(8-kV Contact, 20 ns/div)

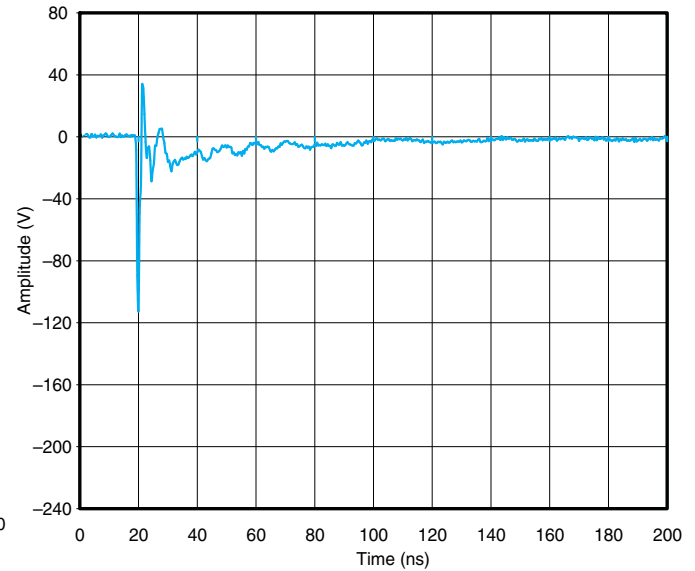


Figure 4. Figure 3. IEC Clamping Waveforms  
(-8-kV Contact, 20 ns/div)

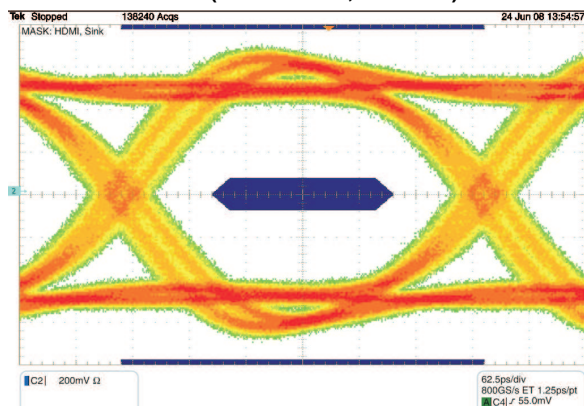


Figure 5. Eye Diagram Without TPD8S009  
(2.5 Gbps Data Rate)

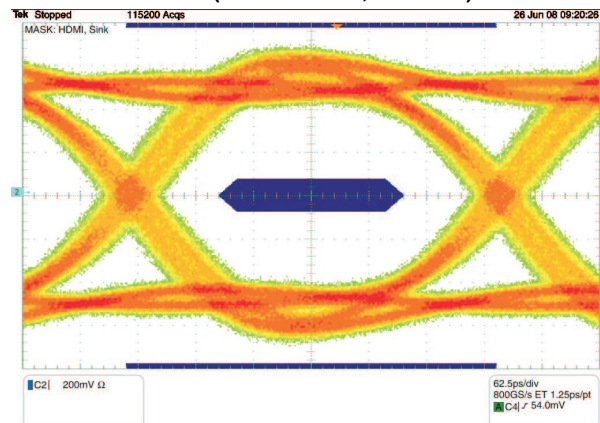
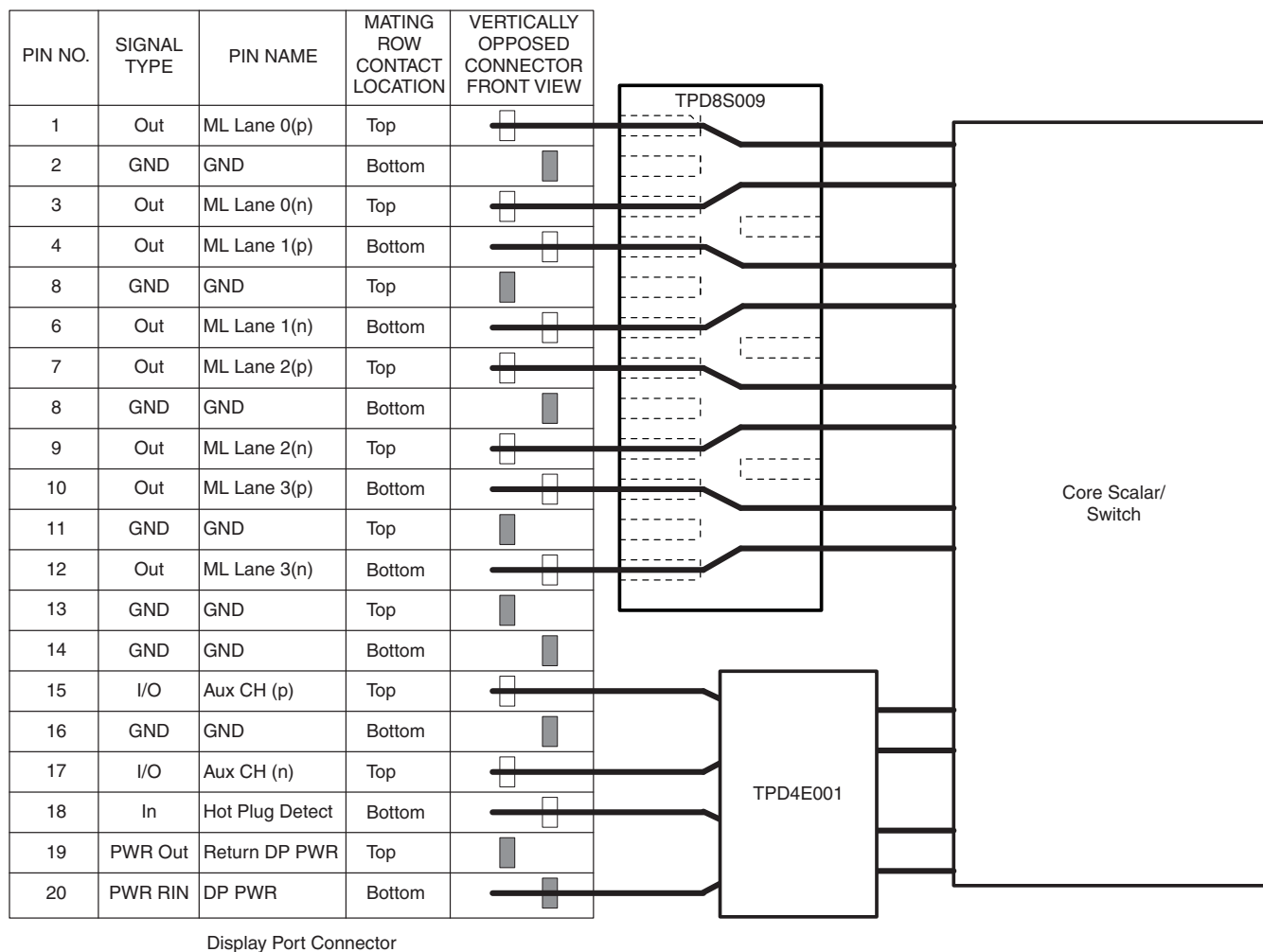


Figure 6. Eye Diagram With TPD8S009  
(2.5 Gbps Data Rate)

## APPLICATION INFORMATION



TPD8S009 and TPD4E001 provide complete ESD protection for display or HDMI interface

**Figure 7. Typical Application**

The TPD8S009 can provide system-level ESD protection to the high-speed differential lines of the HDMI or display ports. The flow-through package offers flexibility for board routing with traces up to 15-mm wide. [Figure 7](#) shows the board-layout scheme for the four differential pair lines. The special pin configuration of the TPD8S009 matches the HDMI or display port pin assignments. It allows the differential signal pairs to couple together after they touch the ESD ports (pins 1–3, 4–6, 7–9, and 10–12) of the TPD8S009.

TPD4E001 is recommended for ESD protection of slow-speed control lines.

**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)
TPD8S009DSMR	ACTIVE	SON	DSM	15	3000	TBD	Call TI	Call TI	<a href="#">Request Free Samples</a>

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

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

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

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

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

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

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

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

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

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

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

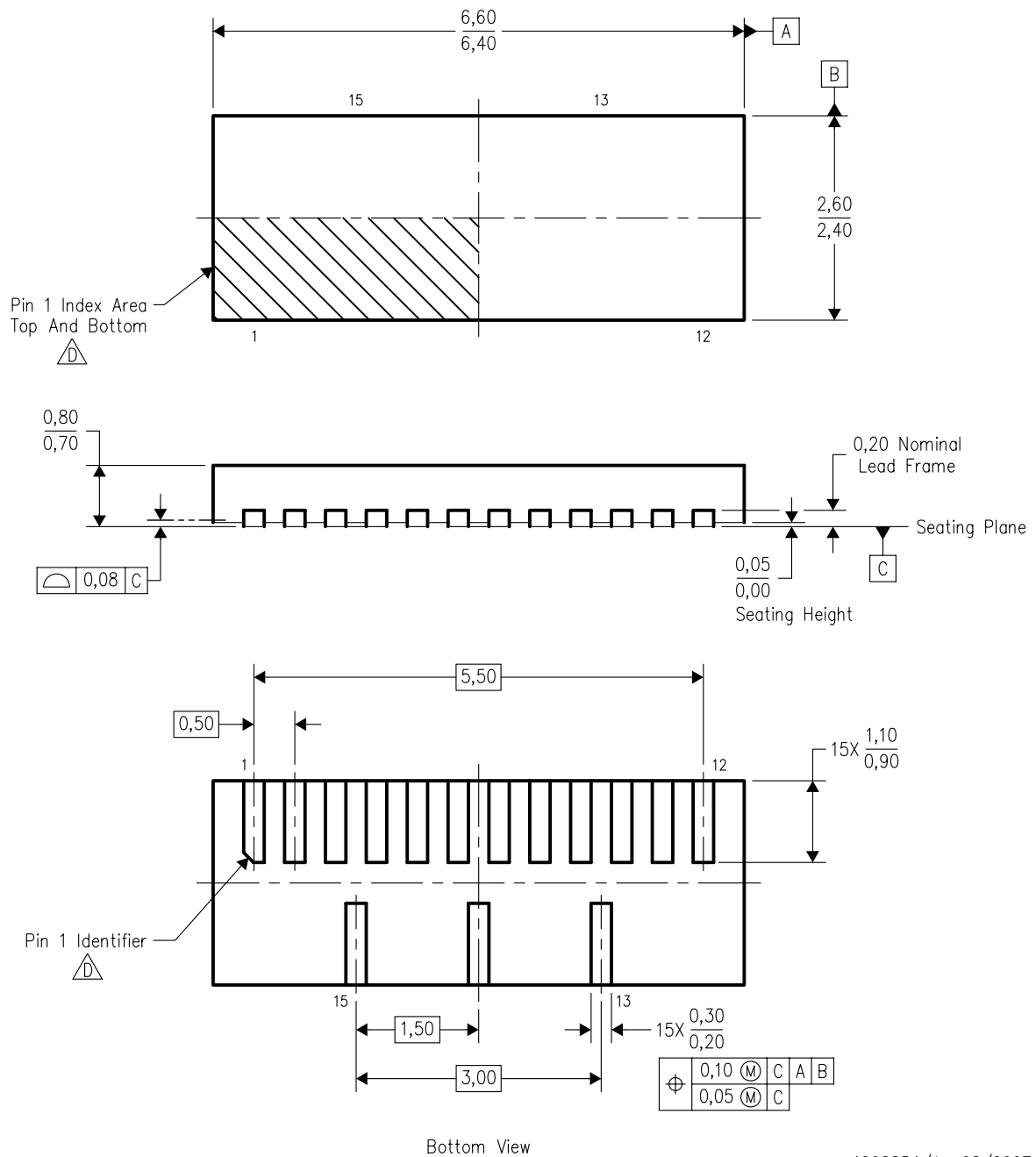
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**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.

DSM (R-PDSO-N15)

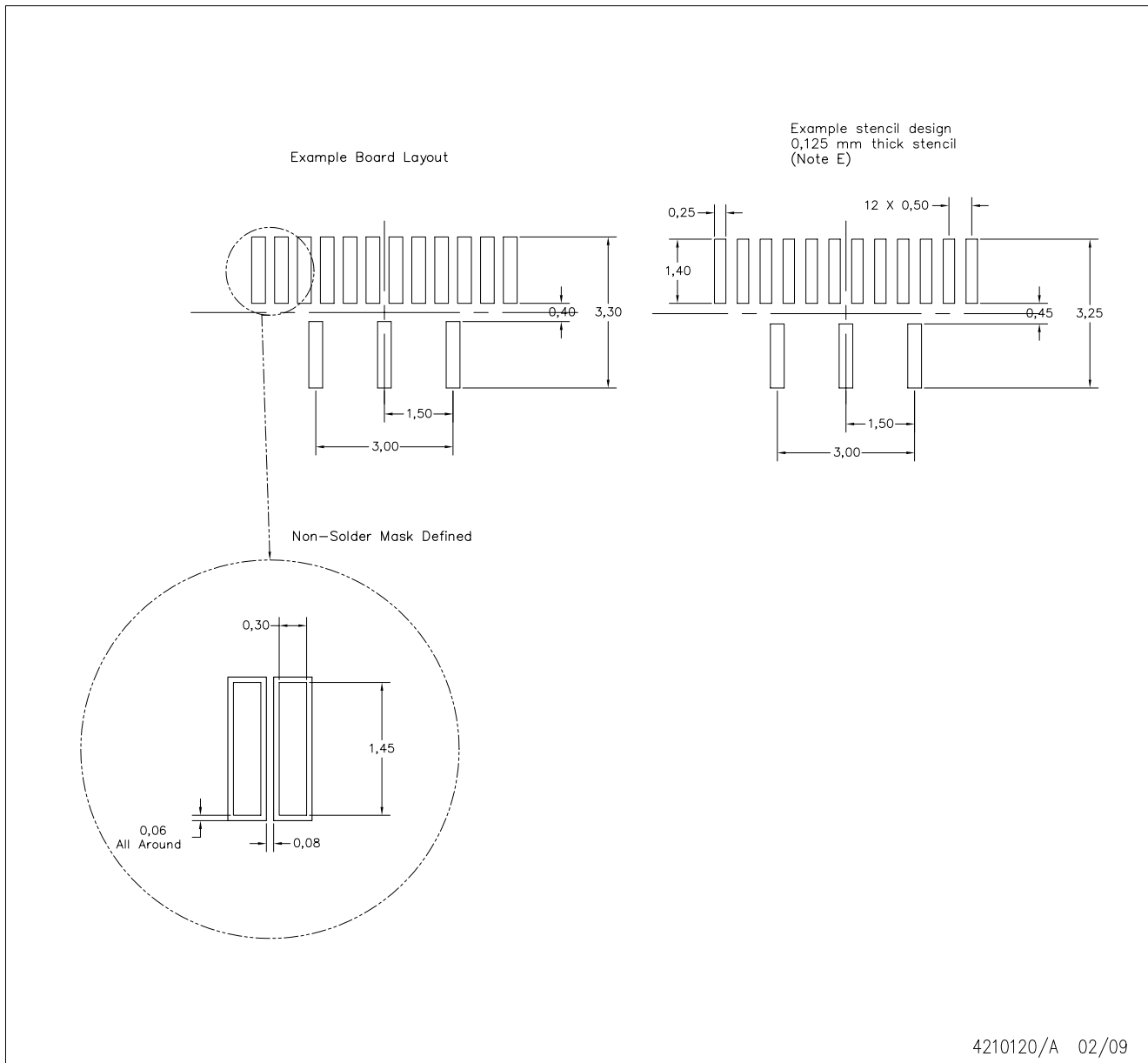
## PLASTIC SMALL OUTLINE



4208854/A 08/2007

- 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. SON (Small Outline No-Lead) package configuration.
  -  D. Pin 1 identifiers are located on both top and bottom of the package and within the zone indicated. The Pin 1 identifiers are either a molded, marked, or metal feature.

## DSM (R-PDSO-N15)

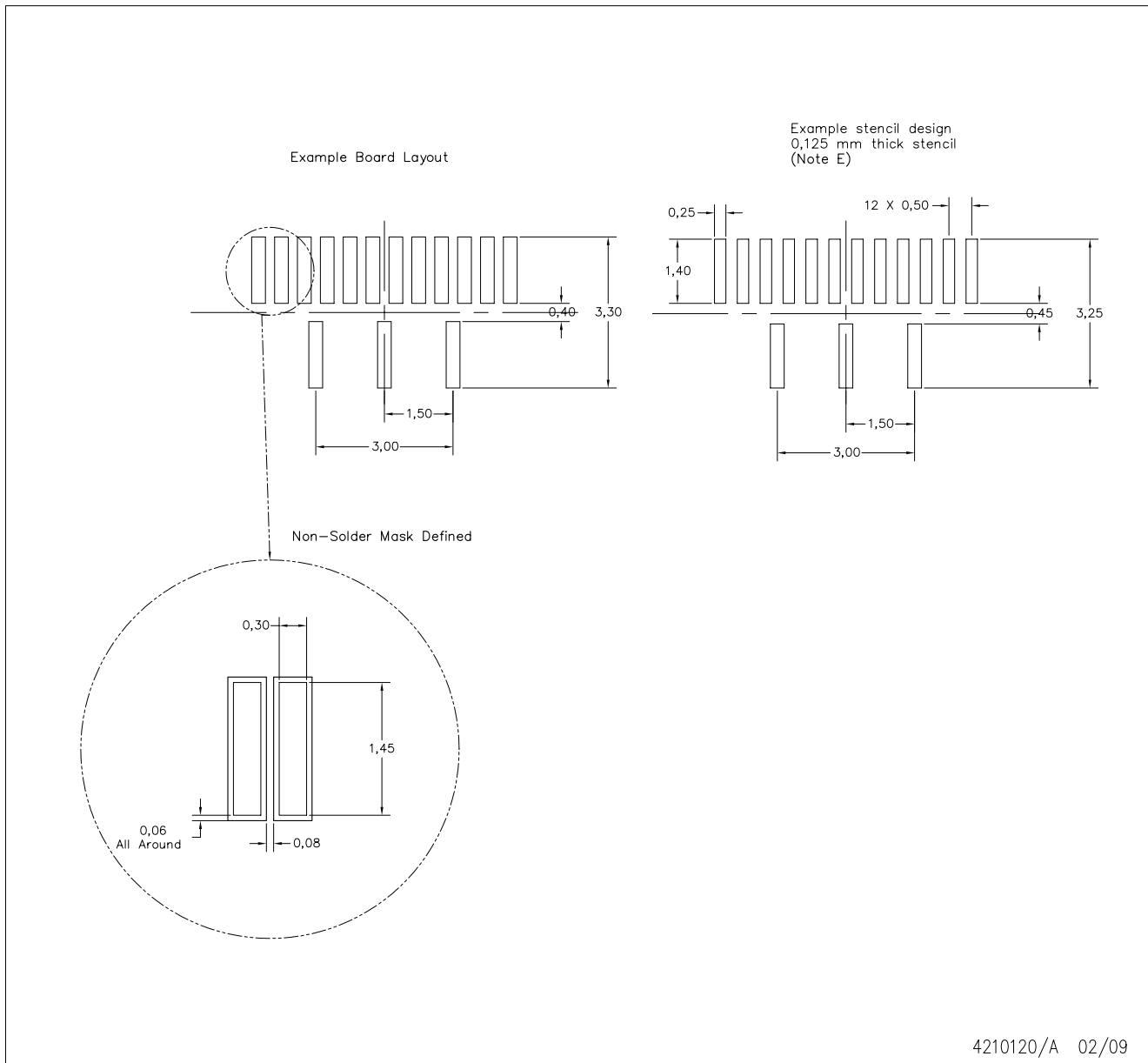


4210120/A 02/09

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



## DSM (R-PDSO-N15)



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

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:

Products		Applications	
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>	Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>	Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>	Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>	Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Energy	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>	Space, Avionics & Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>	Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
		Wireless	<a href="http://www.ti.com/wireless-apps">www.ti.com/wireless-apps</a>