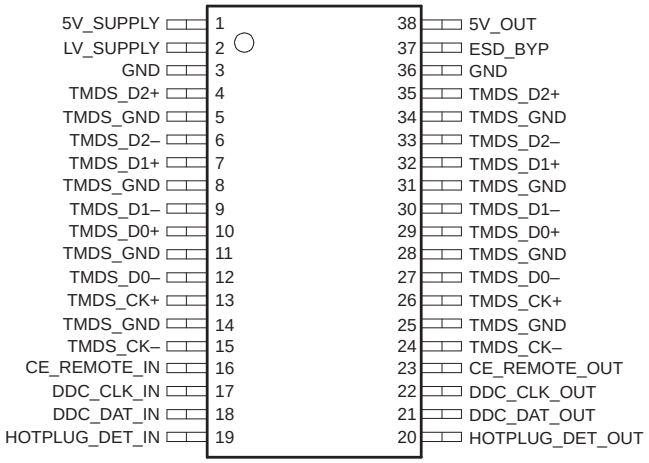
SINGLE-CHIP HDMI TRANSMITTER PORT PROTECTION AND INTERFACE DEVICE

FEATURES

- **Single-Chip ESD Solution for High-Definition Multimedia Interface (HDMI) Driver**
- **Supports HDMI 1.3 Data Rate (–3 dB Frequency > 3 GHz)**
- **0.8-pF Capacitance for High-Speed Transition Minimized Differential Signaling (TMDS) Lines**
- **0.05-pF Matching Capacitance Between the Differential Signal Pair**
- **Integrated Level Shifting for the Control Lines**
- **±8-kV Contact ESD Protection on External Lines**
- **38-Pin Thin Shrink Small-Outline Package (TSSOP) Provides Seamless Layout Option With HDMI Connector**
- **Backdrive Protection**
- **Lead-Free Package**
- **On-Chip Current Regulator With 55-mA Current Output**

DBT PACKAGE
(TOP VIEW)



APPLICATIONS

- **PCs**
- **Consumer Electronics**
- **Set-Top Boxes**
- **DVDRW Players**

DESCRIPTION/ORDERING INFORMATION

The TPD12S521 is a single-chip ESD solution for the high-definition multimedia interface (HDMI) transmitter port. In many cases, the core ICs, such as the scalar chipset, may not have robust ESD cells to sustain system-level ESD strikes. In these cases, the TPD12S521 provides the desired system-level ESD protection, such as the the IEC61000-4-2 (Level 4) ESD, by absorbing the energy associated with the ESD strike.

While providing the ESD protection, the TPD12S521 adds little or no additional glitch in the high-speed differential signals (see Figure 4 and Figure 5). The high-speed transition minimized differential signaling (TMDS) lines add only 0.9-pF capacitance to the lines. In addition, the monolithic integrated circuit technology ensures that there is excellent matching between the two-signal pair 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 low-speed control lines offer voltage-level shifting to eliminate the need for an external voltage level-shifter IC. The control line ESD clamps add 3.5-pF capacitance to the control lines. The 38-pin DBT package offers seamless layout routing option to eliminate the routing glitch for the differential signal pair.

The TPD12S521 provides an on-chip regulator with current output ratings of 55 mA at pin 38. This current enables HDMI receiver detection even when the receiver device is powered off. DBT package pitch (0.5 mm) matches with HDMI connector pitch. In addition, pin mapping follows the same order as the HDMI connector pin mapping. This HDMI receiver port protection and interface device is specifically designed for next-generation HDMI transmitter protection.

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 the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

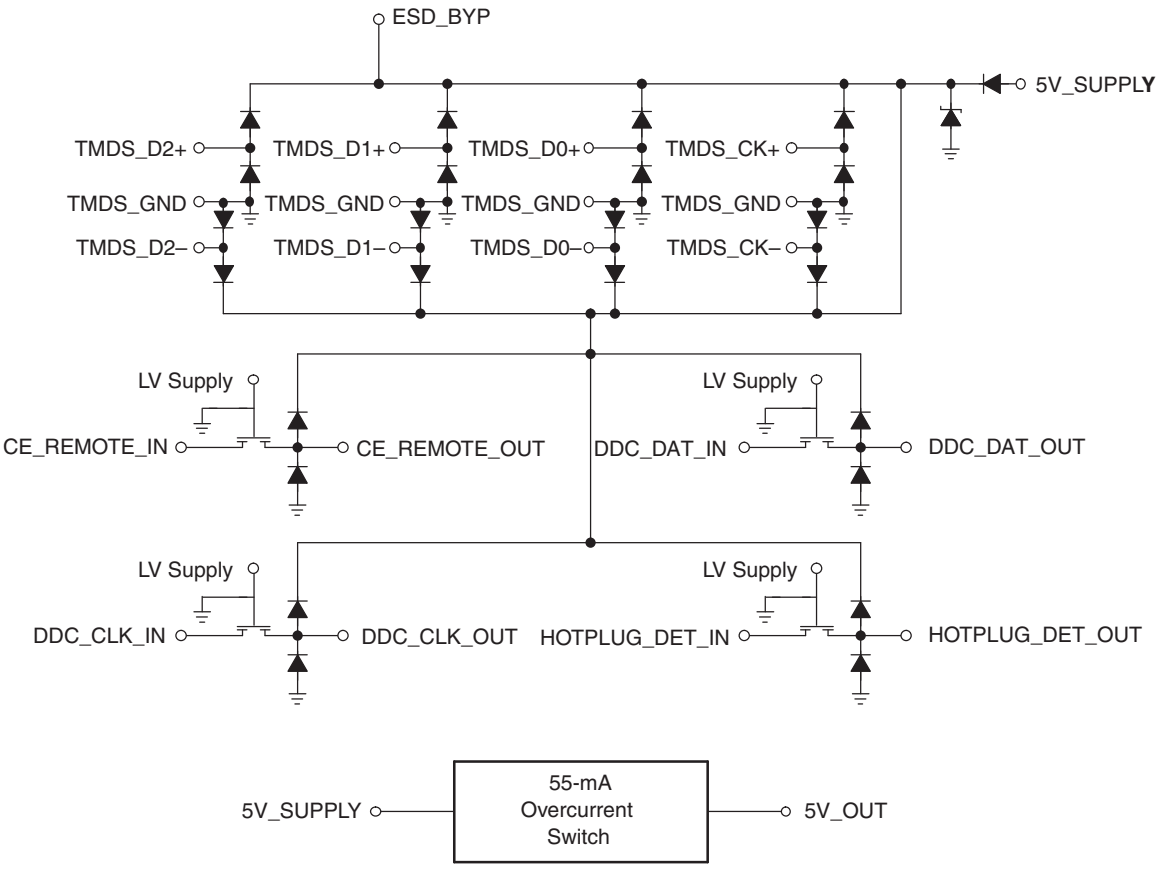
Copyright © 2007–2008, Texas Instruments Incorporated

ORDERING INFORMATION

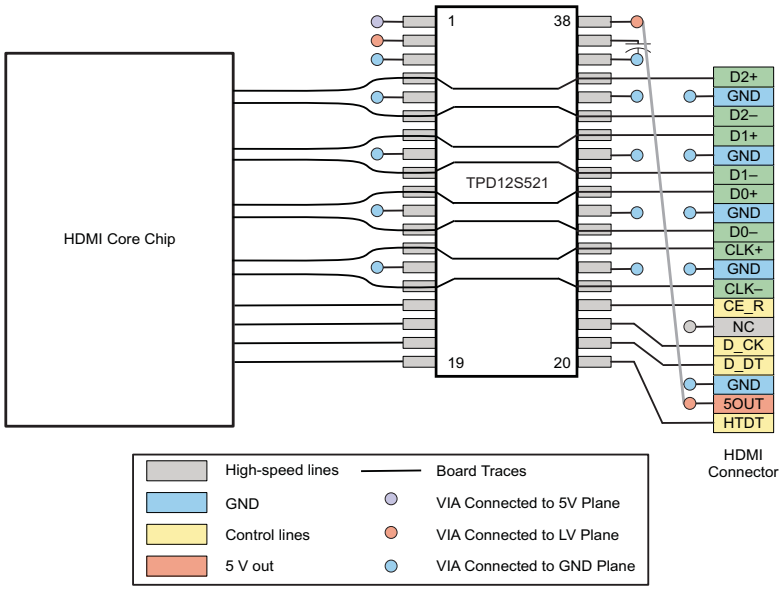
T_A	PACKAGE(1)(2)	ORDERABLE PART NUMBER(3)	TOP-SIDE MARKING
–40°C to 85°C	TSSOP-38 – DBT	TPD12S521DBTR	PN521

(1) Package drawings, thermal data, and symbolization are available at 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.
(3) Parts are shipped in tape-and-reel form, unless otherwise specified.

ELECTRICAL SCHEMATIC



Copyright © 2007–2008, Texas Instruments Incorporated



A. External bypass capacitors and resistor components not included

Figure 1. Board Layout for HDMI Transmitter Using TPD12S521DBTR

PIN DESCRIPTION

NAME	PIN NO.	ESD LEVEL	DESCRIPTION
5V_SUPPLY	1	2 kV(1)	Current source for 5V_OUT
LV_SUPPLY	2	2 kV(1)	Bias for CE/DDC/HOTPLUG level shifters
GND, TMDS_GND	3, 5, 8, 11,14, 25, 28, 31, 34, 36	NA	TMDS ESD and parasitic GND return(2)
TMDS_D2+	4, 35	8 kV(3)	TMDS 0.8-pF ESD protection(4)
TMDS_D2–	6, 33	8 kV(3)	TMDS 0.8-pF ESD protection(4)
TMDS_D1+	7, 32	8 kV(3)	TMDS 0.8-pF ESD protection(4)
TMDS_D1–	9, 30	8 kV(3)	TMDS 0.8-pF ESD protection(4)
TMDS_D0+	10, 29	8 kV(3)	TMDS 0.8-pF ESD protection(4)
TMDS_D0–	12, 27	8 kV(3)	TMDS 0.8-pF ESD protection(4)
TMDS_CK+	13, 26	8 kV(3)	TMDS 0.8-pF ESD protection(4)
TMDS_CK–	15, 24	8 kV(3)	TMDS 0.8-pF ESD protection(4)
CE_REMOTE_IN	16	2 kV(1)	LV_SUPPLY referenced logic level into ASIC
DDC_CLK_IN	17	2 kV(1)	LV_SUPPLY referenced logic level into ASIC
DDC_DAT_IN	18	2 kV(1)	LV_SUPPLY referenced logic level into ASIC
HOTPLUG_DET_IN	19	2 kV(1)	LV_SUPPLY referenced logic level into ASIC
HOTPLUG_DET_OUT	20	8 kV(3)	5 V_SUPPLY referenced logic level out, plus 3.5-pF ESD(5) to connector
DDC_DAT_OUT	21	8 kV(3)	5 V_SUPPLY referenced logic level out, plus 3.5-pF ESD to connector
DDC_CLK_OUT	22	8 kV(3)	5 V_SUPPLY referenced logic level out, plus 3.5-pF ESD to connector
CE_REMOTE_OUT	23	8 kV(3)	5 V_SUPPLY referenced logic level out, plus 3.5-pF ESD to connector
ESD_BYP	37	2 kV(1)	ESD bypass. This pin must be connected to a 0.1-µF ceramic capacitor.
5V_OUT	38	2 kV(1)	5-V regulator output

(1) Human-Body Model (HBM) per MIL-STD-833, Method 3015, $C_{DISCHARGE}$ = 100 pF, $R_{DISCHARGE}$ = 1.5 kΩ, 5V_SUPPLY and LV_SUPPLY within recommended operating conitions, GND = 0 V, and ESD_BYP (pin 37) and HOTPLUG_DET_OUT (pin 20) each bypassed with a 0.1-µF ceramic capacitor connnected to GND.
(2) These pins should be routed directly to the associated GND pins on the HDMI connector, with single-point ground vias at the connector.
(3) Standard IEC 61000-4-2, $C_{DISCHARGE}$ = 150 pF, $R_{DISCHARGE}$ = 330 Ω, 5V_SUPPLY and LV_SUPPLY within recommended operating conditions, GND = 0 V, and ESD_BYP (pin 37) and HOTPLUG_DET_OUT (pin 20) each bypassed with a 0.1-µF ceramic capacitor connected to GND.
(4) These two pins must be connected together inline on the PCB.
(5) This output can be connected to an external 0.1-µF ceramic capacitor, resulting in an increased ESD withstand voltage rating.

Copyright © 2007–2008, Texas Instruments Incorporated

ABSOLUTE MAXIMUM RATINGS(1)

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

		MIN	MAX	UNIT
V_{5V_SUPPLY} V_{LV_SUPPLY}	Supply voltage		6	V
$V_{I/O}$	DC voltage at any channel input	GND – 0.5	6	V
T_{stg}	Storage temperature range	–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.

RECOMMENDED OPERATING CONDITIONS

		MIN	NOM	MAX	UNIT
Operating supply voltage	5V_SUPPLY		5	5.5	V
Bias supply voltage	LV_SUPPLY	1	3.3	5.5	V
Operating temperature		–40		85	°C

Copyright © 2007–2008, Texas Instruments Incorporated

ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
I_{CC5}	Operating supply current	5V_SUPPLY = 5 V				110	130	µA
I_{CC3}	Bias supply current	LV_SUPPLY = 3.3 V				1	5	µA
V_{DROP}	5V_OUT overcurrent output drop	5V_SUPPLY = 5 V, I_{OUT} = 55 mA				150	200	mV
I_{SC}	5V_OUT short-circuit current limit	5V_SUPPLY= 5 V, 5V_OUT = GND			90	135	175	mA
I_{OFF}	OFF-state leakage current, level-shifting NFET	LV_SUPPLY = 0 V				0.1	5	µA
$I_{BACKDRIVE}$	Current conducted from output pins to V_SUPPLY rails when powered down	5V_SUPPLY < V_{CH_OUT}	TMDS_D[2:0]+/–, TMDS_CK+/–, CE_REMOTE_OUT, DDC_DAT_OUT, DDC_CLK_OUT, HOTPLUG_DET_OUT, 5V_OUT			0.1	5	µA
V_{ON}	Voltage drop across level-shifting NFET when ON	LV_SUPPLY = 2.5 V, V_S = GND, I_{DS} = 3 mA			75	95	140	mV
V_F	Diode forward voltage	I_F = 8 mA, T_A = 25°C(1)	Top diode			0.85		V
			Bottom diode			0.85		
V_{ESD}	ESD withstand voltage	Pins 4, 7, 10, 13, 20–24, 27, 30, 33(1)(2)		IEC	±8			kV
		Pins 1, 2, 16–19, 37, 38(1)(3)		HBM	±2			
V_{CL}	Channel clamp voltage at ±8-kV HBM ESD	T_A = 25°C(1)(3)	Positive transients			9		V
			Negative transients			–9		
R_{DYN}	Dynamic resistance	I = 1 A, T_A = 25°C(4)	Positive transients			3		Ω
			Negative transients			1.5		
I_{LEAK}	TMDS channel leakage current	T_A = 25°C(1)				0.01	1	µA
C_{IN}, TMDS	TMDS channel input capacitance	5V_SUPPLY= 5 V, Measured at 1 MHz, V_{BIAS} = 2.5 V(1)				0.8	1.0	pF
ΔC_{IN}, TMDS	TMDS channel input capacitance matching	5V_SUPPLY= 5 V, Measured at 1 MHz, V_{BIAS} = 2.5 V(1)(5)				0.05		pF
C_{MUTUAL}	Mutual capacitance between signal pin and adjacent signal pin	5V_SUPPLY= 0 V, Measured at 1 MHz, V_{BIAS} = 2.5 V(1)				0.07		pF
C_{IN}	Level-shifting input capacitance, capacitance to GND	5V_SUPPLY= 0 V, Measured at 100 KHz, V_{BIAS} = 2.5 V(1)		DDC		3.5	4	pF
				CEC		3.5	4	
				HP		3.5	4	

(1) This parameter is specified by design and verified by device characterization.
(2) Standard IEC 61000-4-2, $C_{DISCHARGE}$ = 150 pF, $R_{DISCHARGE}$ = 330 Ω
(3) Human-Body Model (HBM) per MIL-STD-883, Method 3015, $C_{DISCHARGE}$ = 100 pF, $R_{DISCHARGE}$ = 1.5 kΩ
(4) These measurements performed with no external capacitor on ESD_BYP.
(5) Intrapair matching, each TMDS pair (i.e., D+, D–)

Copyright © 2007–2008, Texas Instruments Incorporated

TYPICAL PERFORMANCE

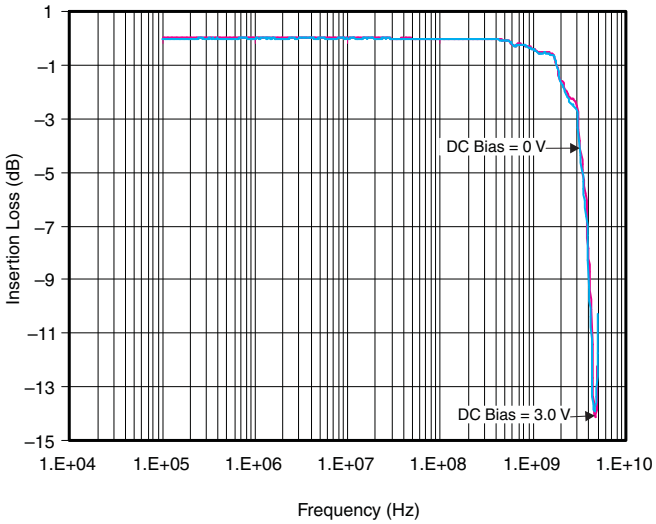


Figure 2. Insertion Loss Performance Across Frequency

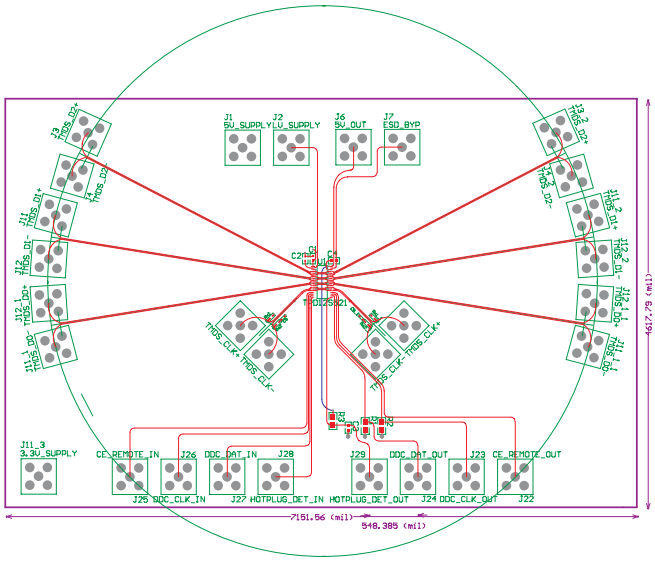


Figure 3. Test Board to Measure Eye Diagram for the TPD12S521 (Refer to Eye Diagram Plot)

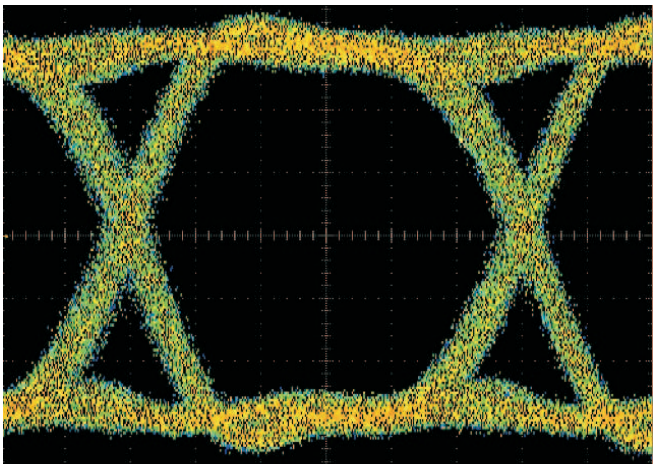


Figure 4. HDMI 1.65Gbps Eye Diagram With TPD12S521 on a Test Board

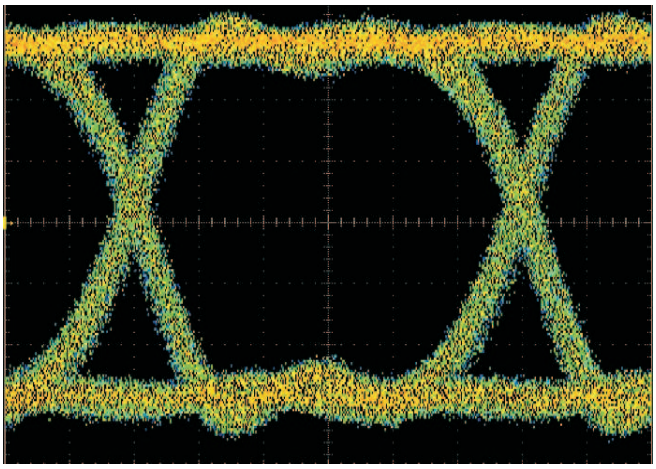


Figure 5. HDMI 1.65Gbps Eye Diagram Without TPD12S521 in the Socket in the Test Board

Copyright © 2007–2008, Texas Instruments Incorporated

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TPD12S521DBTR	ACTIVE	TSSOP	DBT	38	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
TPD12S521DBTRG4	ACTIVE	TSSOP	DBT	38	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR

(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)

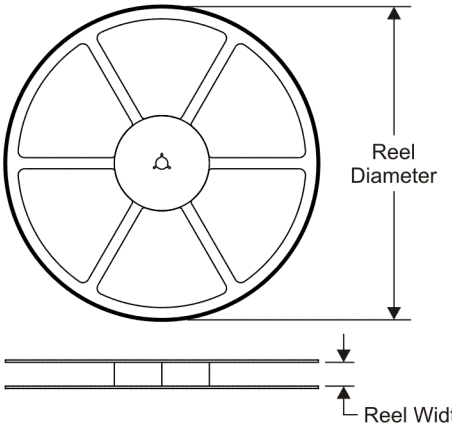
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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.

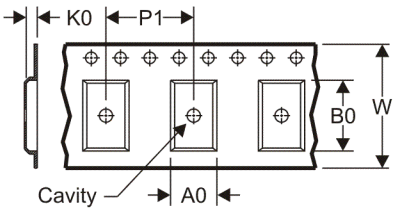
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

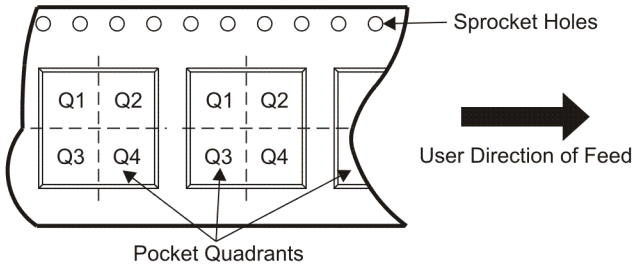


TAPE DIMENSIONS



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

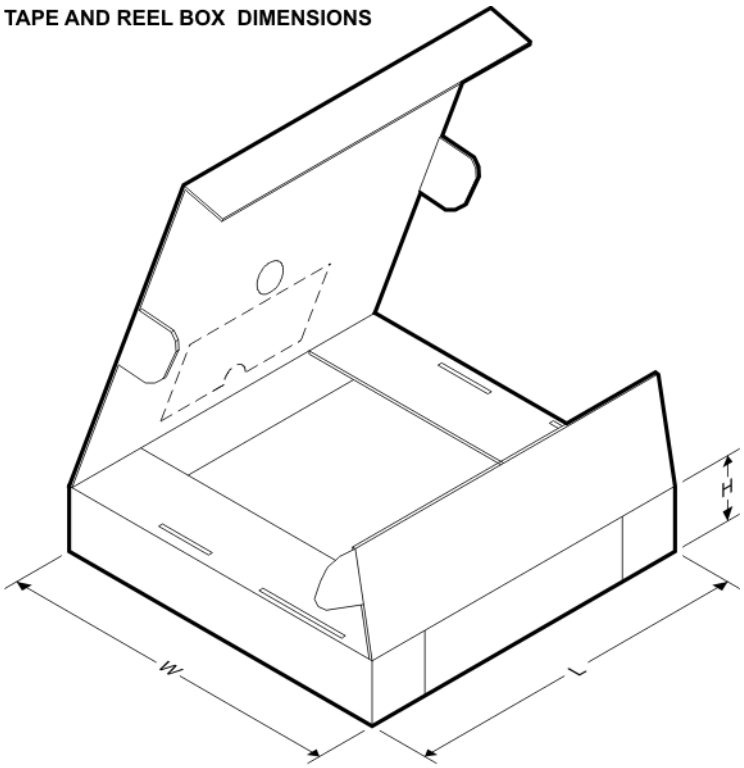
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPD12S521DBTR	TSSOP	DBT	38	2000	330.0	16.4	6.9	10.2	1.8	12.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS

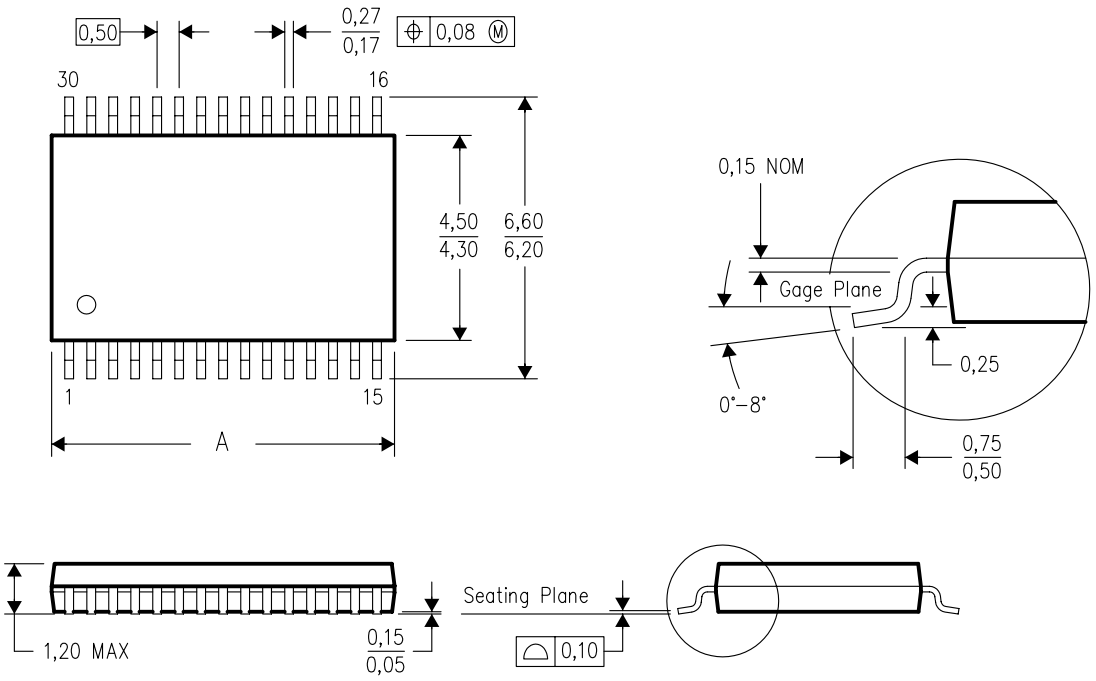


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPD12S521DBTR	TSSOP	DBT	38	2000	346.0	346.0	33.0

DBT (R–PDSO–G**) PLASTIC SMALL–OUTLINE PACKAGE

30 PINS SHOWN



DIM \ PINS **	20	24	28	30	38	44	50
A MAX	5,10	6,60	7,90	7,90	9,80	11,40	12,60
A MIN	4,90	6,40	7,70	7,70	9,60	11,20	12,40

4073252/F 09/05

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.
D. Falls within JEDEC MO–153 except 44 pin package length.

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	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Clocks and Timers	www.ti.com/clocks	Digital Control	www.ti.com/digitalcontrol
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Telephony	www.ti.com/telephony
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2008, Texas Instruments Incorporated