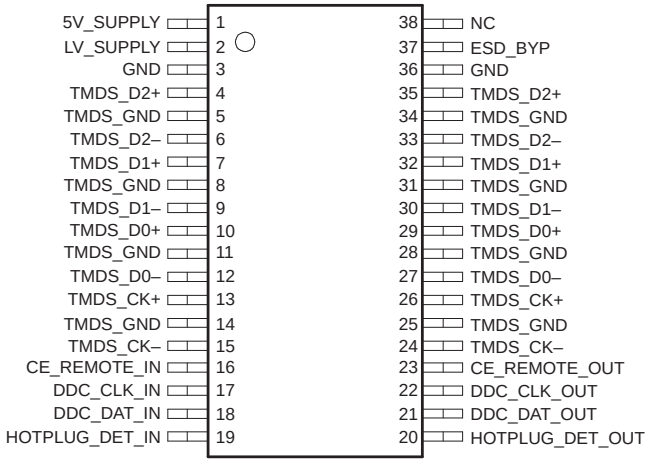
SINGLE-CHIP HDMI RECEIVER PORT PROTECTION AND INTERFACE DEVICE

FEATURES

- **Single-Chip ESD Solution for High-Definition Multmedia Interface (HDMI)**
- **Supports HDMI 1.3 Data Rate**
- **0.8-pF Capacitance for High-Speed Transition Minimized Directional Signaling (TMDS) Lines**
- **0.05-pF Matching Capacitance Between Differential Signal Pair**
- **Integrated Level Shifting for Control Lines**
- **±8-kV Contact Electrostatic Discharge (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**

DBT PACKAGE
(TOP VIEW)



APPLICATIONS

- **Video Interfaces**
- **Consumer Electronics**
- **Displays and Digital Televisions**

DESCRIPTION/ORDERING INFORMATION

The TPD12S520 is a single-chip electrostatic dischare (ESD) solution for the high-definition multmedia interface (HDMI) receiver 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 TPD12S520 provides the desired system-level ESD protection, such as the IEC61000-4-2 (Level 4) ESD, by absorbing the energy associated with the ESD strike.

While providing ESD protection, the TPD12S520 adds little or no additional glitch in the high-speed differential signals (see Figure 3 and Figure 4). High-speed transition minimized directional signaling (TMDS) lines add only 0.8-pF capacitance to the lines. In addition, monolithic integrated circuit technology ensures 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. Control-line ESD clamps add 3.5-pF capacitance to the control lines.

The 38-pin DBT package offers a seamless layout routing option (see Figure 1) to eliminate the routing glitch for the differential signal pair. DBT package pitch (0.5 mm) matches HDMI connector pitch. In addition, the pin mapping follows the same order as the HDMI connector pin mapping. This HDMI receiver port protection and interface device is designed specifically for next-generation HDMI receiver-interface protection.

ORDERING INFORMATION

T_A	PACKAGE(1)(2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	TSSOP-38 – DBT	Tape and reel	TPD12S520DBTR	PN520

(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.

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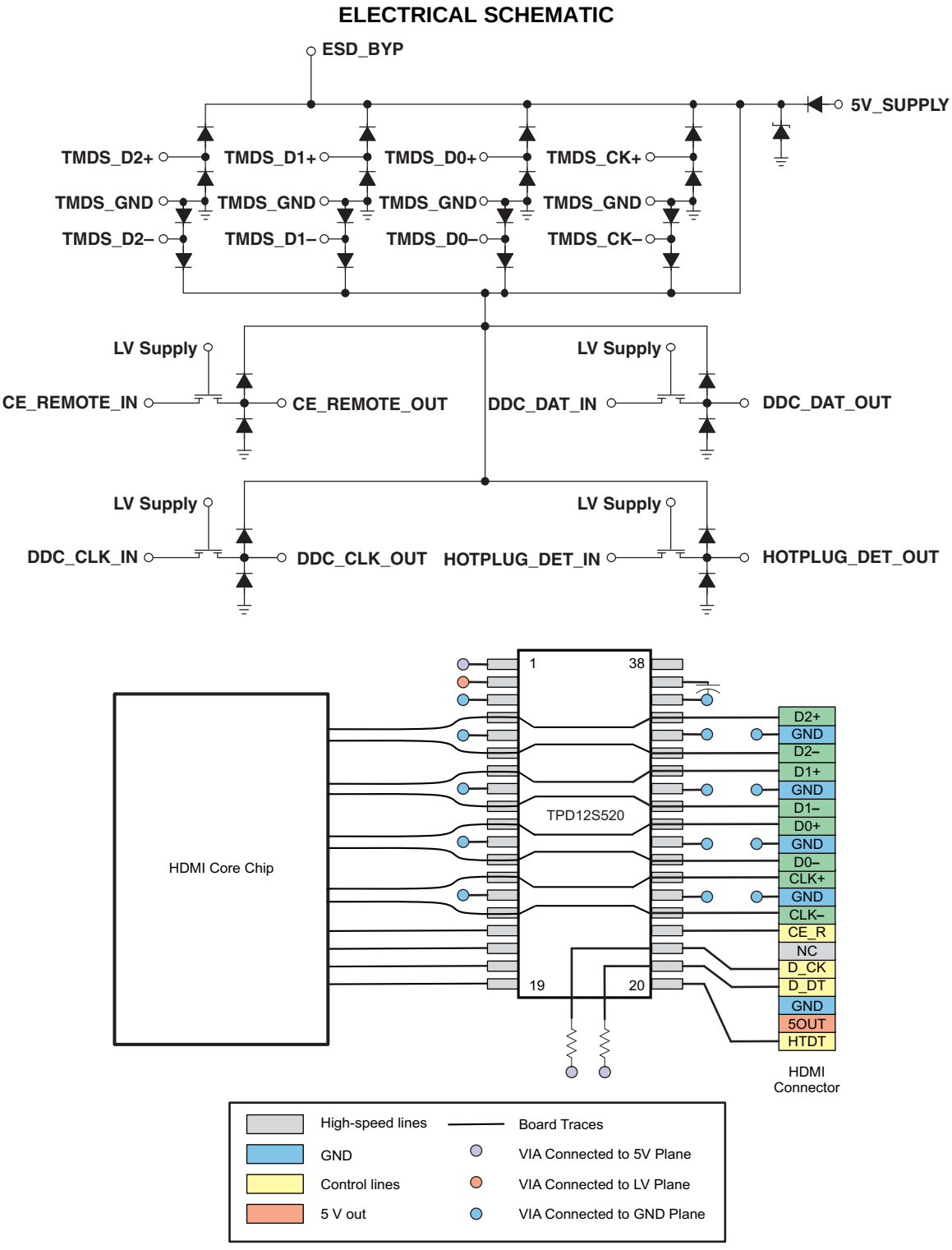


A. External bypass capacitors and resistor components not included

Figure 1. Board Layout for HDMI Transmitter Using TPD12S520DBTR

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 0.9-pF ESD protection(4)
TMDS_D2–	6, 33	8 kV(3)	TMDS 0.9-pF ESD protection(4)
TMDS_D1+	7, 32	8 kV(3)	TMDS 0.9-pF ESD protection(4)
TMDS_D1–	9, 30	8 kV(3)	TMDS 0.9-pF ESD protection(4)
TMDS_D0+	10, 29	8 kV(3)	TMDS 0.9-pF ESD protection(4)
TMDS_D0–	12, 27	8 kV(3)	TMDS 0.9-pF ESD protection(4)
TMDS_CK+	13, 26	8 kV(3)	TMDS 0.9-pF ESD protection(4)
TMDS_CK–	15, 24	8 kV(3)	TMDS 0.9-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.
NC	38	NA	No connection

(1) Human-Body Model (HBM) per MIL-STD-883, Method 3015, $C_{DISCHARGE}$ = 100 pF, $R_{DISCHARGE}$ = 1.5 kΩ, 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.
(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.

ABSOLUTE MAXIMUM RATINGS

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

		MIN	MAX	UNIT
V_{5V_SUPPLY} V_{LV_SUPPLY}	Supply voltage		6	V
V_{IO}	DC voltage at any channel input		6	V
T_{stg}	Storage temperature range	–65	150	°C

RECOMMENDED OPERATING CONDITIONS

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

ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
I_{5V}	Operating supply current	5V_SUPPLY = 5 V			1	5	µA
I_{LV}	Bias supply current	LV_SUPPLY = 3.3 V			1	2	µA
I_{OFF}	OFF-state leakage current, level-shifting NFET	LV_SUPPLY = 0 V			0.1	1	µA
$I_{BACKDRIVE}$	Current conducted from output pins to V_SUPPLY rails when powered down	5V_SUPPLY < V_{CH_OUT}	TMDS_[2:0]+/–, TMDS_CK+/–, CE_REMOTE_OUT, DDC_DAT_OUT, DDC_CLK_OUT, HOTPLUG_DET_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		1		V
			Bottom diode		1		
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(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, VBIAS = 2.5 V(1)	DDC		3.5	4	pF
			CEC		3.5	4	
			HP		3.5	4	

(1) This parameter is specified by design.
(2) 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.
(3) HBM per MIL-STD-883, Method 3015, $C_{DISCHARGE}$ = 100 pF, $R_{DISCHARGE}$ = 1.5 kΩ, 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 measurements performed with no external capacitor on ESD_BYP.
(5) Intrapair matching, each TMDS pair (i.e., D+, D–)

TYPICAL PERFORMANCE

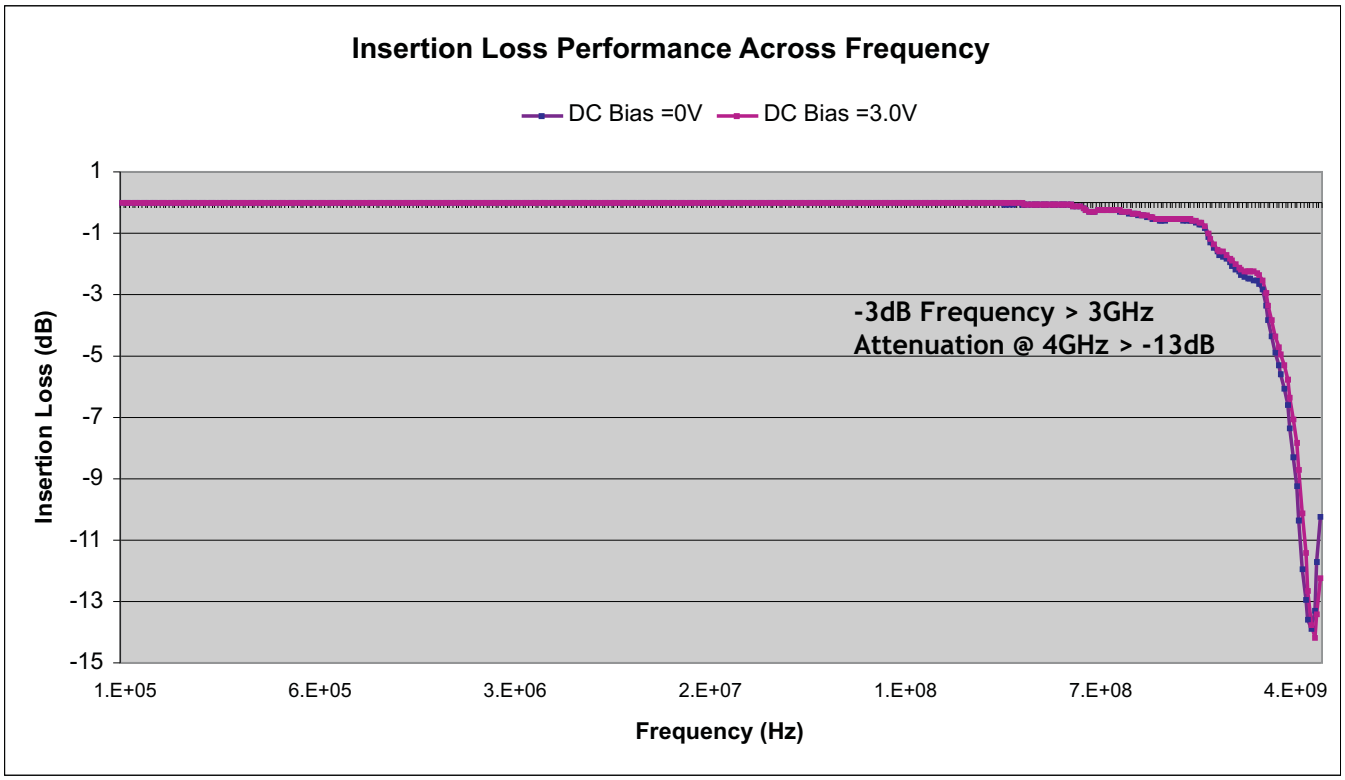


Figure 2. Insertion Loss Performance Across Frequency

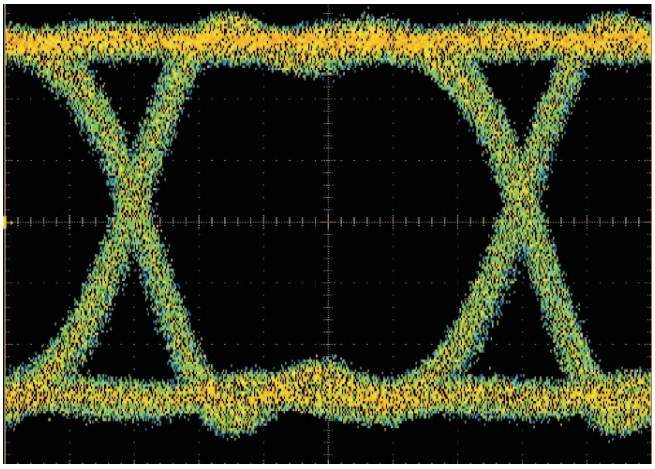


Figure 3. Eye Diagram Without TPD12S520 in Test Socket (Across Differential Data Lines, Data Rate 1.6 Gbps)

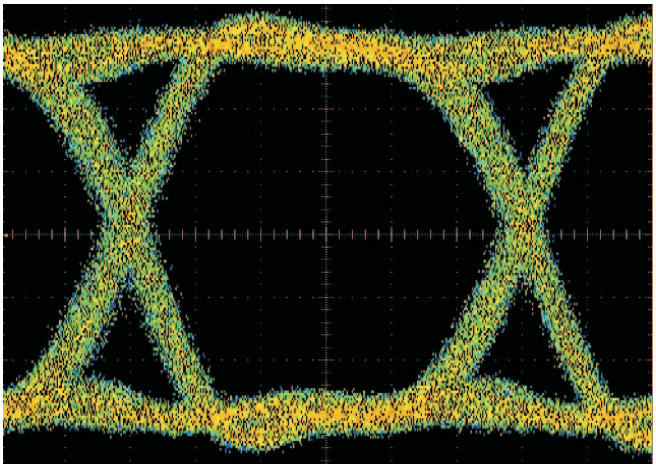


Figure 4. Eye Diagram With TPD12S520 in Test Socket (Across Differential Data Lines, Data Rate 1.6 Gbps)

TYPICAL PERFORMANCE (continued)

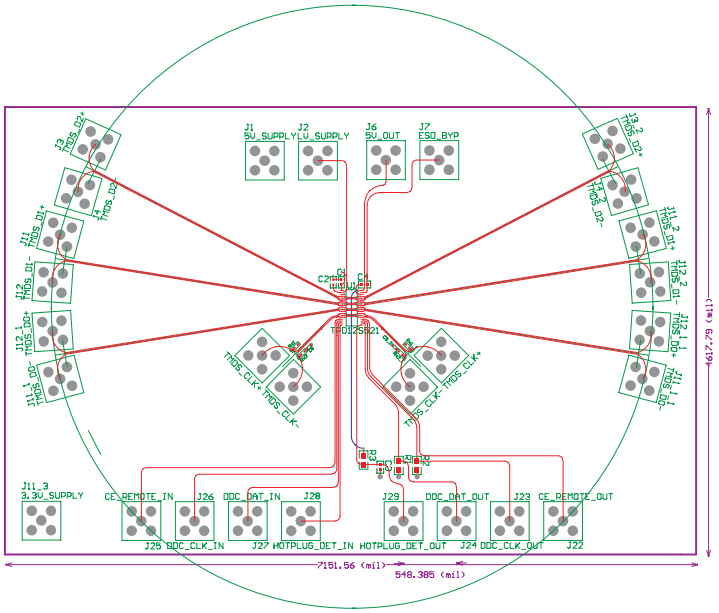


Figure 5. Test Board to Measure Eye Diagram for TPD12S520 (See Eye Diagrams)

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TPD12S520DBTR	ACTIVE	TSSOP	DBT	38	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR

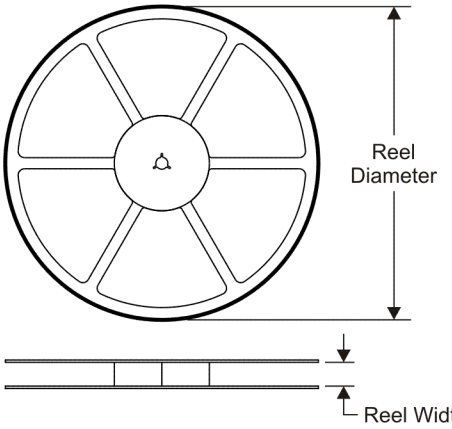
(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, 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)

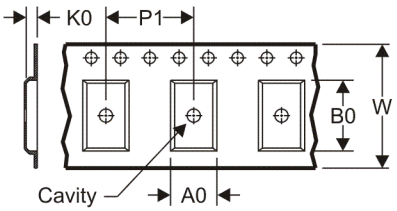
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

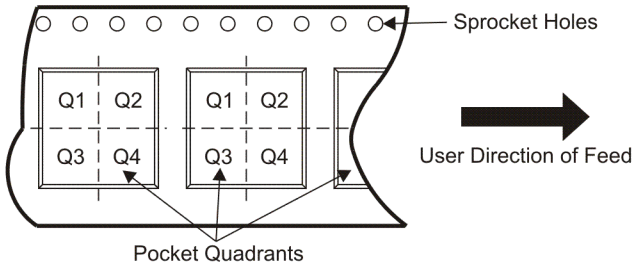


TAPE DIMENSIONS



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

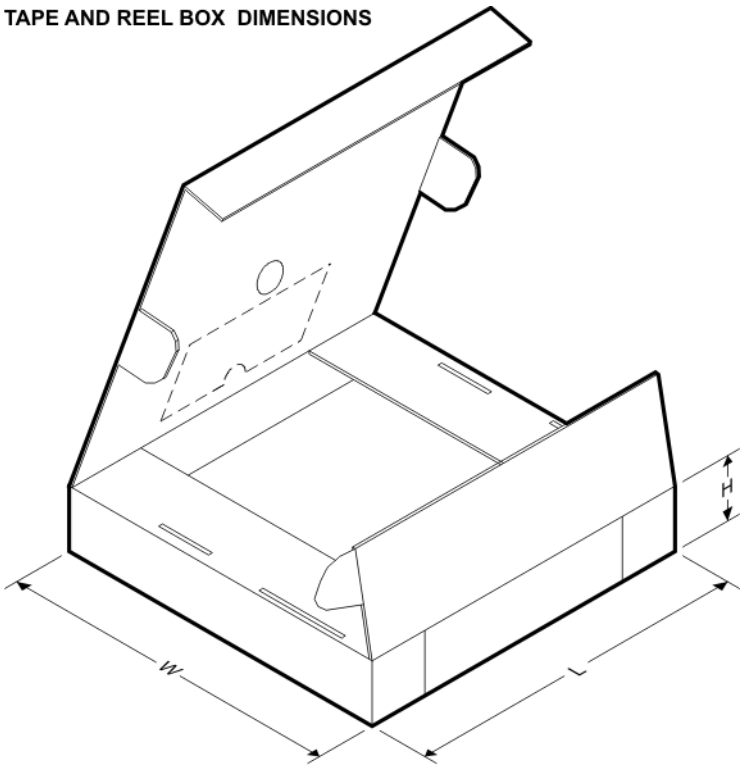
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPD12S520DBTR	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)
TPD12S520DBTR	TSSOP	DBT	38	2000	346.0	346.0	33.0

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