

Low-Power, High-Speed Buffer for CCD Sensor

Check for Samples: [VSP1000](#)

FEATURES

- **High Speed:**
 - 210 MHz, 3-dB Bandwidth
- **Fast Settling Time**
- **Adjustable Active Load Current**
- **Adjustable Drive Strength**
- **Low Power: 20 mW**
- **Ultra-Small Package:**
 - 1-mm × 1-mm Ultra-Thin 0.35-mm QFN

DESCRIPTION

The VSP1000 is a high-speed, low-noise, low-power, fast-settling, unity-gain buffer. It is specially designed for use between charge-coupled device (CCD) sensors and analog front-ends (AFEs). The device has an adjustable active load current that can load the CCD sensor output appropriately. The VSP1000 also features an adjustable output drive strength that can be set in accordance with the bandwidth requirements. At a 2-mA drive current, the device provides a bandwidth of 210 MHz, which allows for very low power operation with good performance. An ultra-small package of 1 mm × 1 mm and 0.35-mm height helps in saving printed circuit board (PCB) space and achieving a very low profile.

The VSP1000 is ideal for driving Texas Instruments AFEs for CCD sensors and, in general, any analog-to-digital converter (ADC) inputs. The adjustable load current allows for easy interfacing with a variety of CCD sensors from various manufacturers.



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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.

PACKAGE/ORDERING INFORMATION⁽¹⁾

PRODUCT	PACKAGE-LEAD	PACKAGE DESIGNATOR	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER	TRANSPORT MEDIA, QUANTITY
VSP1000	QFN-6	DSF	0°C to +85°C	VSP1000DSF	VSP1000DSFT	Tape and Reel, 250
					VSP1000DSFR	Tape and Reel, 5000

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or visit the device product folder at www.ti.com.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

Over free-air temperature range, unless otherwise noted.

		VSP1000	UNIT
Supply voltage	VCC	20.0	V
Input voltage		–0.3 to VCC + 0.3	V
Input current	Any pin except supplies	±10	mA
Ambient temperature under bias		–25 to +85	°C
Storage temperature		–55 to +125	°C
Junction temperature		+150	°C
Package temperature (IR reflow, peak)		+250	°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.

ELECTRICAL CHARACTERISTICS

All specifications at $T_A = +25^{\circ}\text{C}$, $V_{CC} = 13\text{ V}$, $R_{IDRV} = 90\text{ k}\Omega$, and $C_{LOAD} = 22\text{ pF}$, unless otherwise noted.

PARAMETER		TEST CONDITIONS	VSP1000			UNIT
			MIN	TYP	MAX	
POWER SUPPLY						
V _{CC}	Supply voltage		10	13	16	V
I _{CC}	Supply current		2			mA
DYNAMIC PERFORMANCE						
	Gain	1-MHz, 200-mV _{PP} input	0.999			ns
	Rise time	V _{IN} = 7.5 V to 8.5 V	5			ns
	Fall time	V _{IN} = 8.5 V to 7.5 V	6			ns
	I/O delay time	V _{IN} = 7.5 V to 8.5 V	1.28			ns
	–3-dB bandwidth	100-mV _{PP} input	210			MHz
V _{IN}	Input voltage range	V _{CC} = 13 V	1.5		10.5	V
T _A	Operating free-air temperature		0		+85	°C

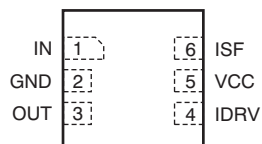
THERMAL INFORMATION

THERMAL METRIC ⁽¹⁾		VSP1000	UNITS
		DSF	
		6 PINS	
θ_{JA}	Junction-to-ambient thermal resistance	333.2	$^{\circ}\text{C/W}$
θ_{JCtop}	Junction-to-case (top) thermal resistance	56.9	
θ_{JB}	Junction-to-board thermal resistance	239	
Ψ_{JT}	Junction-to-top characterization parameter	13.9	
Ψ_{JB}	Junction-to-board characterization parameter	236	
θ_{JCbott}	Junction-to-case (bottom) thermal resistance	202	

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).

PIN CONFIGURATION

DSF PACKAGE
1-mm × 1-mm × 0.35-mm QFN-6
(TOP VIEW)



PIN ASSIGNMENTS

PIN NAME	PIN NUMBER	TYPE	DESCRIPTION
IN	1	Analog input	Input terminal; connect this pin to the sensor output
VEE	2	Ground	Negative supply terminal; must be connected to ground
OUT	3	Analog output	Output terminal; connect this pin to the AFE input
IDRV	4	Analog input	Drive current adjustment; refer to the application diagram for further details
VCC	5	Power	Positive supply terminal; must be decoupled to the VEE terminal with a 0.1-μF capacitor
ISF	6	Analog input	Sink current adjustment; refer to the application diagram for further details

FUNCTIONAL BLOCK DIAGRAM

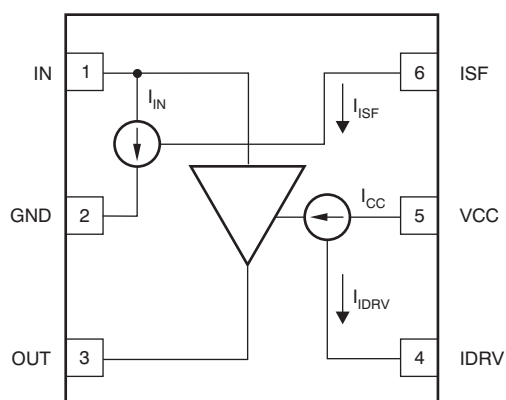


Figure 1. Block Diagram

TYPICAL CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $V_{CC} = 13\text{ V}$, $R_{IDRV} = 90\text{ k}\Omega$, $R_{ISF} = 300\text{ k}\Omega$, and $C_{LOAD} = 22\text{ pF}$, unless otherwise noted.

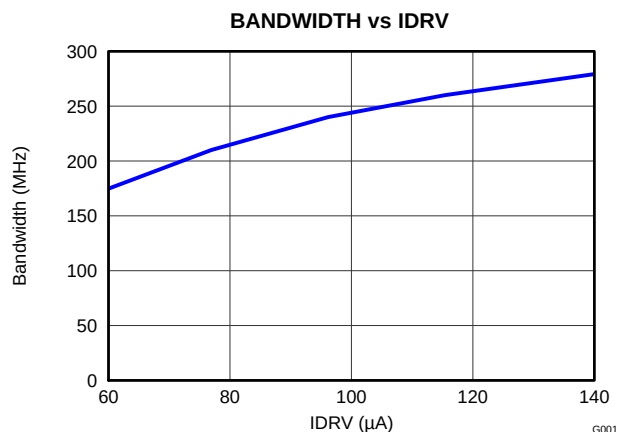


Figure 2.

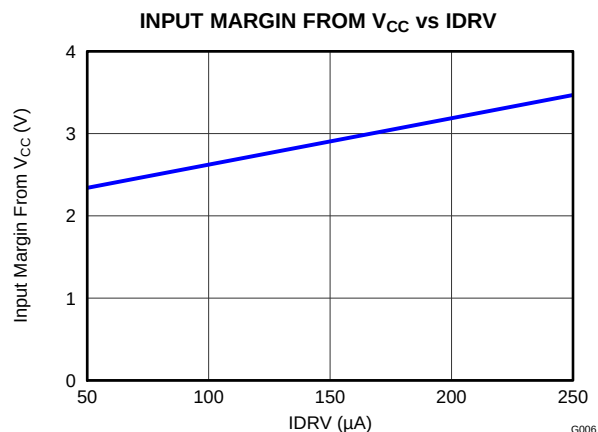


Figure 3.

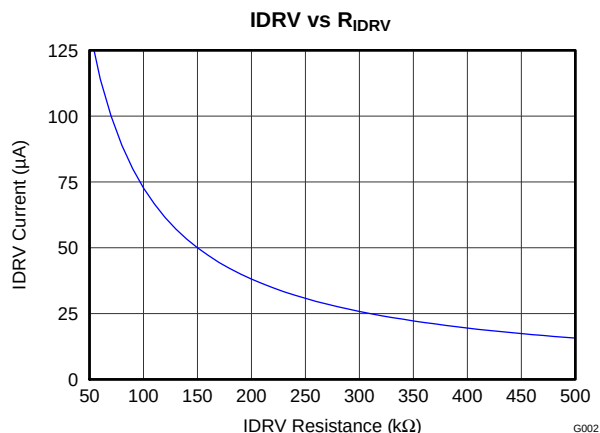


Figure 4.

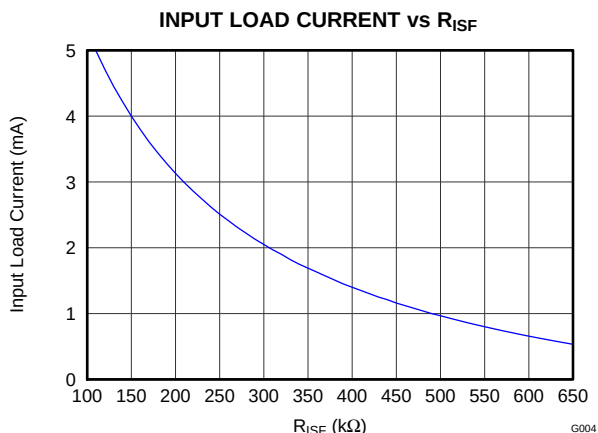


Figure 5.

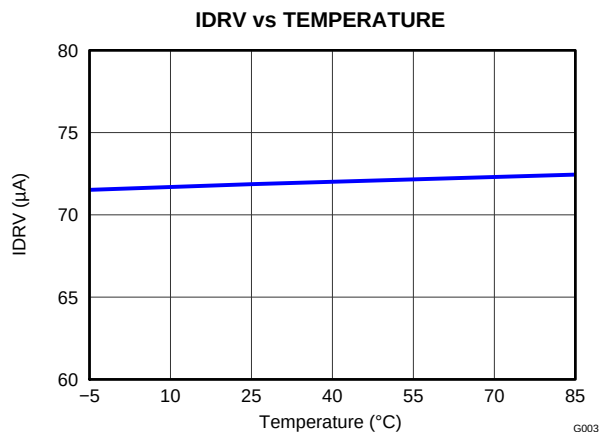


Figure 6.

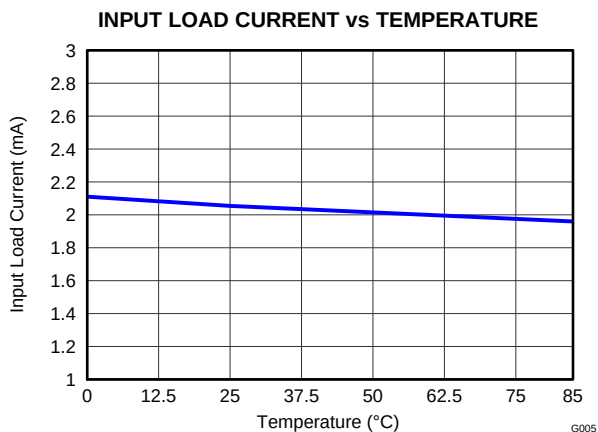
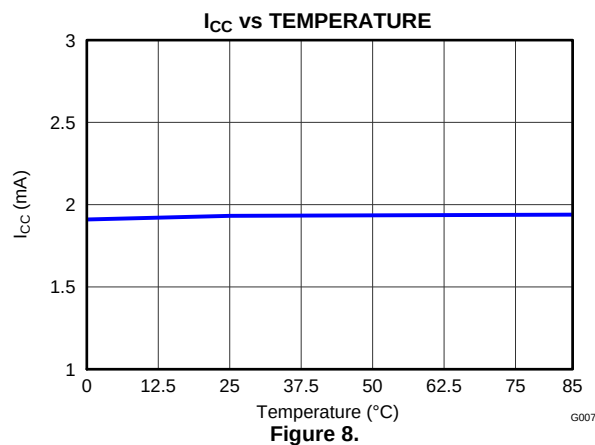


Figure 7.

TYPICAL CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_{CC} = 13\text{ V}$, $R_{IDRV} = 90\text{ k}\Omega$, $R_{ISF} = 300\text{ k}\Omega$, and $C_{LOAD} = 22\text{ pF}$, unless otherwise noted.



OVERVIEW

TYPICAL APPLICATION CIRCUIT

Figure 9 shows a typical application circuit for the VSP1000.

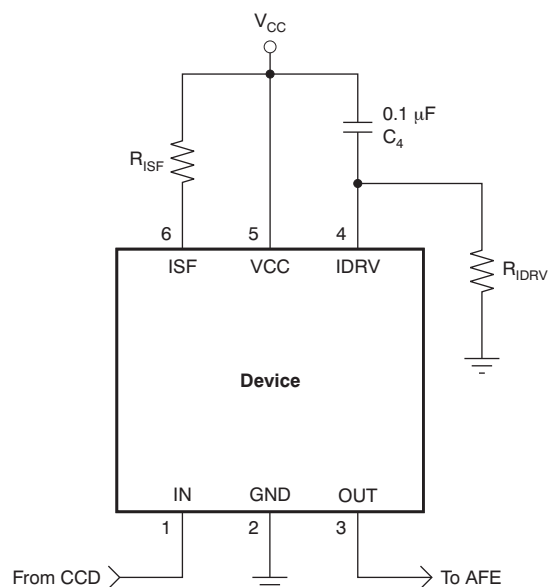


Figure 9. Typical Application Circuit

DESIGN EQUATIONS

The CCD outputs must be loaded with current for proper operation. The VSP1000 provides the ability to draw adjustable current through the IN pin. The value of the input load current can be set by choosing an appropriate value of R_{ISF} connected to the ISF pin, as per [Equation 1](#).

$$I_{IN} = \frac{\left(\frac{V_{CC} \times 100 \text{ k}\Omega}{(R_{ISF} + 100 \text{ k}\Omega)} \right) - 1.2}{1 \text{ k}\Omega} \quad (1)$$

The bandwidth of the VSP1000 can be adjusted using the IDRV pin. The resistor connected at IDRV determines the drive strength of the output buffer as well as the total quiescent current of the VSP1000. [Equation 2](#) and [Equation 3](#) describe the relationship between R_{IDRV} and the drive strength. C_{IDRV} is used to increase the power-supply rejection ratio of the device. A value of 0.1 μF for C_{IDRV} is recommended.

$$I_{DRV} = \frac{(V_{CC} - 5)}{(R_{IDRV} + 10 \text{ k}\Omega)} \quad (2)$$

$$I_{CC} = 26 \times I_{DRV} \quad (3)$$

EXAMPLE CONFIGURATIONS

[Table 1](#) details several example configurations for the VSP1000. All examples are with $V_{CC} = 13 \text{ V}$.

Table 1. Example Configurations

CONFIGURATION	I_{CC} (mA)	R_{ISF} (k Ω)	R_{IDRV} (k Ω)
Bandwidth = 170 MHz , $I_{IN} = 2 \text{ mA}$	1.5	300	133
Bandwidth = 170 MHz , $I_{IN} = 4 \text{ mA}$	1.5	150	133
Bandwidth = 210 MHz , $I_{IN} = 2 \text{ mA}$	2	300	91
Bandwidth = 210 MHz , $I_{IN} = 4 \text{ mA}$	2	150	91
Bandwidth = 260 MHz , $I_{IN} = 2 \text{ mA}$	3	300	62
Bandwidth = 260 MHz , $I_{IN} = 4 \text{ mA}$	3	150	62

LAYOUT GUIDELINES

The decoupling capacitors C_{IDRV} , R_{IDRV} , and R_{ISF} should be placed as close as possible to the VSP1000.

REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (September 2011) to Revision A	Page
• Updated Figure 4	5
• Updated Figure 5	5

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
VSP1000DSFR	Active	Production	SON (DSF) 6	5000 LARGE T&R	Yes	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	0 to 85	VK
VSP1000DSFR.B	Active	Production	SON (DSF) 6	5000 LARGE T&R	Yes	NIPDAUAG	Level-1-260C-UNLIM	0 to 85	VK
VSP1000DSFT	Active	Production	SON (DSF) 6	250 SMALL T&R	Yes	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	0 to 85	VK
VSP1000DSFT.B	Active	Production	SON (DSF) 6	250 SMALL T&R	Yes	NIPDAUAG	Level-1-260C-UNLIM	0 to 85	VK

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

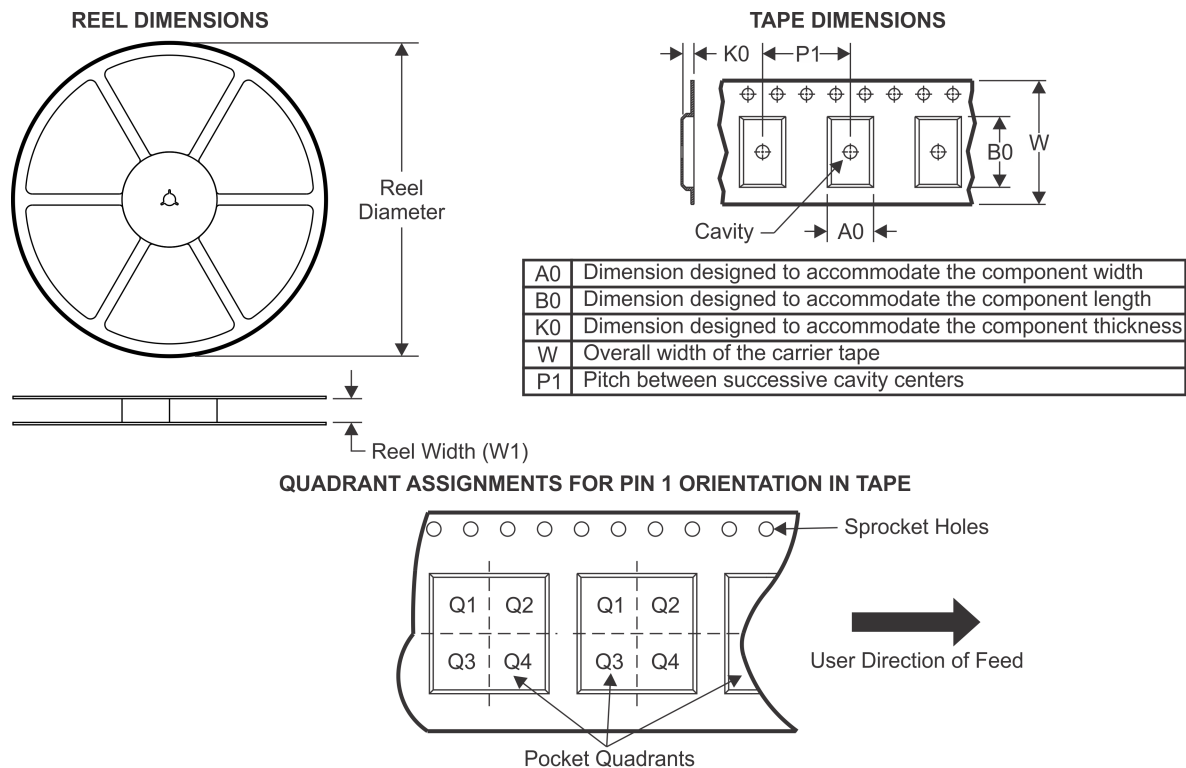
⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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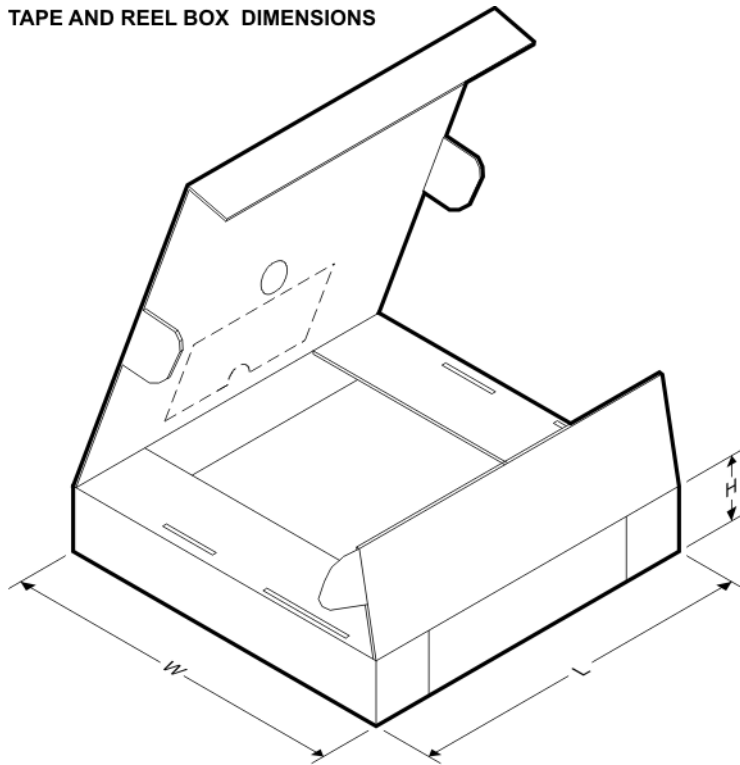
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TAPE AND REEL INFORMATION


*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
VSP1000DSFR	SON	DSF	6	5000	180.0	9.5	1.16	1.16	0.63	4.0	8.0	Q2
VSP1000DSFT	SON	DSF	6	250	180.0	9.5	1.16	1.16	0.63	4.0	8.0	Q2

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

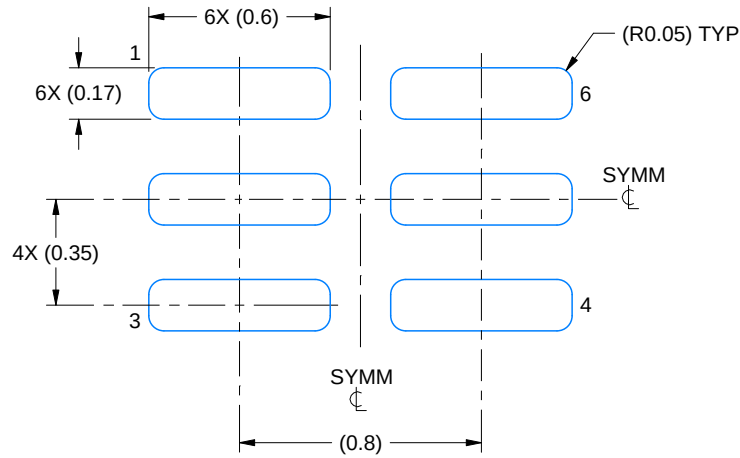
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
VSP1000DSFR	SON	DSF	6	5000	184.0	184.0	19.0
VSP1000DSFT	SON	DSF	6	250	184.0	184.0	19.0

EXAMPLE BOARD LAYOUT

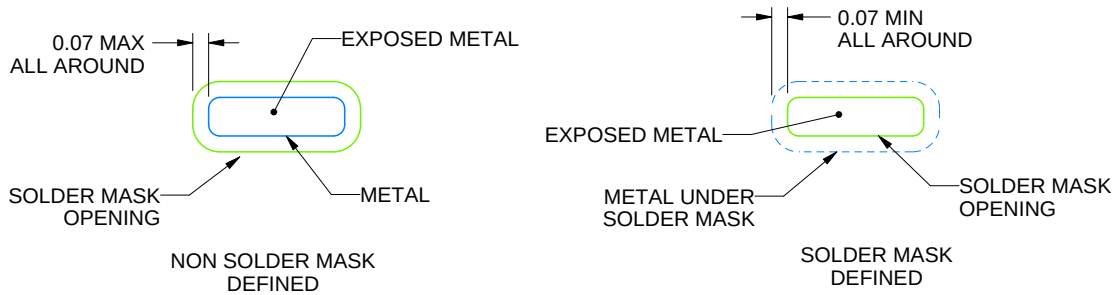
DSF0006A

X2SON - 0.4 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:40X



SOLDER MASK DETAILS

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NOTES: (continued)

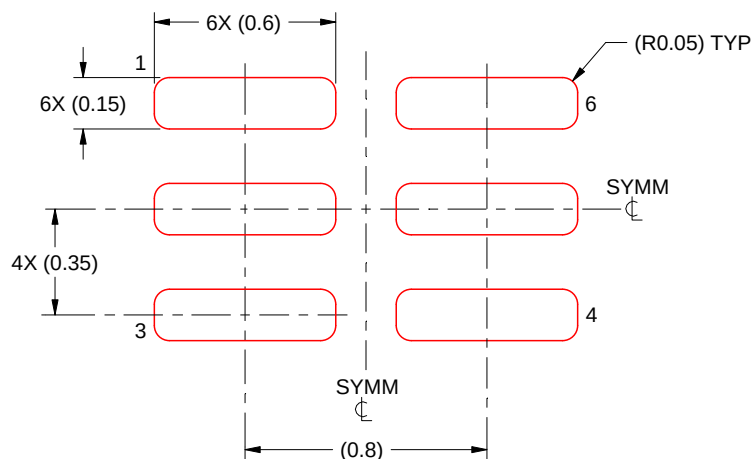
4. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/sluea271).

EXAMPLE STENCIL DESIGN

DSF0006A

X2SON - 0.4 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.09 mm THICK STENCIL

PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:40X

4220597/B 06/2022

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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