CSD25501F3 –20V P-Channel FemtoFET™ MOSFET

1 Features

- Low on-resistance
- Ultra-low Q_g and Q_{gd}
- Ultra-small footprint
  - 0.7mm × 0.6mm
- Low profile
  - 0.22mm max height
- Integrated ESD protection diode
- Lead and halogen free
- RoHS compliant

2 Applications

- Optimized for load switch applications
- Battery applications
- Handheld and mobile applications

3 Description

This –20V, 64mΩ, P-Channel FemtoFET™ MOSFET is designed and optimized to minimize the footprint in many handheld and mobile applications. This technology is capable of replacing standard small signal MOSFETs while providing a substantial reduction in footprint size. The integrated 10kΩ clamp resistor (R_C) allows the gate voltage (V_{GS}) to be operated above the maximum internal gate oxide value of –6V, depending on duty cycle. The gate leakage (I_{GSS}) through the diode increases as V_{GS} is increased above –6V.

Product Summary

T_A = 25°C		TYPICAL VALUE		UNIT
V_{DS}	Drain-to-Source Voltage	–20		V
Q_g	Gate Charge Total (–4.5V)	1.02		nC
Q_{gd}	Gate Charge Gate-to-Drain	0.09		nC
$R_{DS(on)}$	Drain-to-Source On-Resistance	V_{GS} = –1.8V	120	mΩ
		V_{GS} = –2.5V	86	
		V_{GS} = –4.5V	64	
$V_{GS(th)}$	Threshold Voltage	–0.75		V

Device Information

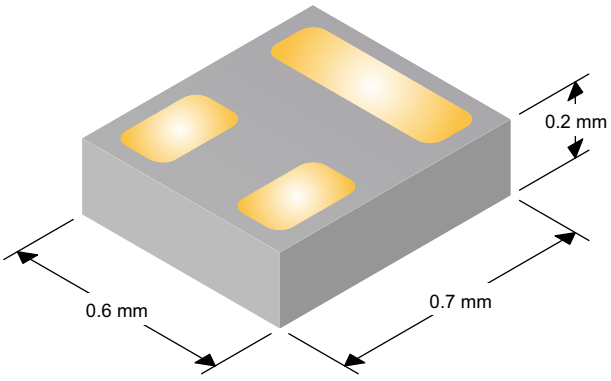
DEVICE(1)	QTY	MEDIA	PACKAGE	SHIP
CSD25501F3	3000	7 Inch Reel	Femto 0.73mm × 0.64mm Land Grid Array (LGA)	Tape and Reel
CSD25501F3T	250			

(1) For all available packages, see the orderable addendum at the end of the data sheet.

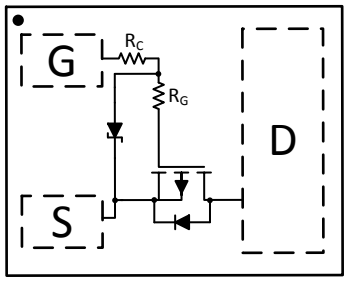
Absolute Maximum Ratings

T_A = 25°C (unless otherwise stated)		VALUE	UNIT
V_{DS}	Drain-to-Source Voltage	–20	V
V_{GS}	Gate-to-Source Voltage	–20	V
I_D	Continuous Drain Current(1)	–3.6	A
I_{DM}	Pulsed Drain Current(1) (2)	–13.6	A
P_D	Power Dissipation(1)	500	mW
$V_{(ESD)}$	Human Body Model (HBM)	4000	V
	Charged Device Model (CDM)	2000	
T_J, T_{stg}	Operating Junction, Storage Temperature	–55 to 150	°C

(1) Typical $R_{\theta JA}$ = 255°C/W mounted on FR4 material with minimum Cu mounting area.
(2) Pulse duration ≤ 100µs, duty cycle ≤ 1%.



Typical Part Dimensions



Top View

Table of Contents

1 Features....1
2 Applications....1
3 Description....1
4 Specifications....3
4.1 Electrical Characteristics....3
4.2 Thermal Information....3
4.3 Typical MOSFET Characteristics....4
5 Device and Documentation Support....6
5.1 Receiving Notification of Documentation Updates....6
5.2 Support Resources....6
5.3 Trademarks....6
5.4 Electrostatic Discharge Caution....6
5.5 Glossary....6
6 Revision History....6
7 Mechanical, Packaging, and Orderable Information....7

4 Specifications

4.1 Electrical Characteristics

T_A = 25°C (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
STATIC CHARACTERISTICS						
BV_{DSS}	Drain-to-source voltage	V_{GS} = 0V, I_{DS} = –250µA	–20			V
I_{DSS}	Drain-to-source leakage current	V_{GS} = 0V, V_{DS} = –16V			–50	nA
I_{GSS}	Gate-to-source leakage current	V_{DS} = 0V, V_{GS} = –6V			–50	nA
		V_{DS} = 0V, V_{GS} = –16V			–1	mA
$V_{GS(th)}$	Gate-to-source threshold voltage	V_{DS} = V_{GS}, I_{DS} = –250µA	–0.45	–0.75	–1.05	V
$R_{DS(on)}$	Drain-to-source on-resistance	V_{GS} = –1.8V, I_{DS} = –0.1A		120	260	mΩ
		V_{GS} = –2.5V, I_{DS} = –0.4A		86	125	
		V_{GS} = –4.5V, I_{DS} = –0.4A		64	76	
g_{fs}	Transconductance	V_{DS} = –2V, I_{DS} = –0.4A		3.4		S
DYNAMIC CHARACTERISTICS						
C_{iss}	Input capacitance	V_{GS} = 0V, V_{DS} = –10V, f = 100kHz		295	385	pF
C_{oss}	Output capacitance			70	91	pF
C_{rss}	Reverse transfer capacitance			4.1	5.3	pF
R_G	Series gate resistance			33		Ω
R_C	Series clamp resistance			10,000		Ω
Q_g	Gate charge total (–4.5 V)	V_{DS} = –10V, I_{DS} = –0.4A		1.02	1.33	nC
Q_{gd}	Gate charge gate-to-drain			0.09		nC
Q_{gs}	Gate charge gate-to-source			0.45		nC
$Q_{g(th)}$	Gate charge at V_{th}			0.36		nC
Q_{oss}	Output charge	V_{DS} = –10V, V_{GS} = 0V		1.8		nC
$t_{d(on)}$	Turnon delay time	V_{DS} = –10V, V_{GS} = –4.5V, I_{DS} = –0.4A, R_G = 0Ω		474		ns
t_r	Rise time			428		ns
$t_{d(off)}$	Turnoff delay time			1154		ns
t_f	Fall time			945		ns
DIODE CHARACTERISTICS						
V_{SD}	Diode forward voltage	I_{SD} = –0.4A, V_{GS} = 0V		–0.73	–0.95	V
Q_{rr}	Reverse recovery charge	V_{DS} = –10V, I_F = –0.4A, di/dt = 200A/µs		3.0		nC
t_{rr}	Reverse recovery time			7.4		ns

4.2 Thermal Information

T_A = 25°C (unless otherwise stated)

THERMAL METRIC		TYPICAL VALUES	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance(1)	90	°C/W
	Junction-to-ambient thermal resistance(2)	255	°C/W

(1) Device mounted on FR4 material with 1in^2 (6.45cm^2), 2oz (0.071mm) thick Cu.
(2) Device mounted on FR4 material with minimum Cu mounting area.

4.3 Typical MOSFET Characteristics

T_A = 25°C (unless otherwise stated)

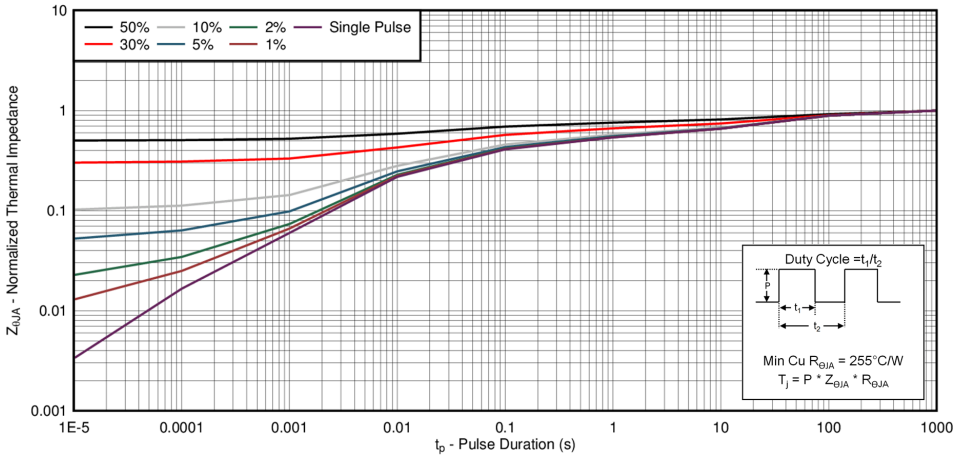


Figure 4-1. Transient Thermal Impedance

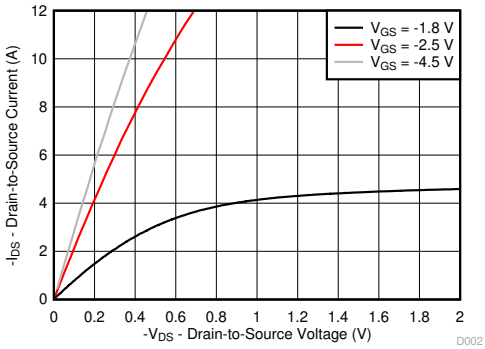
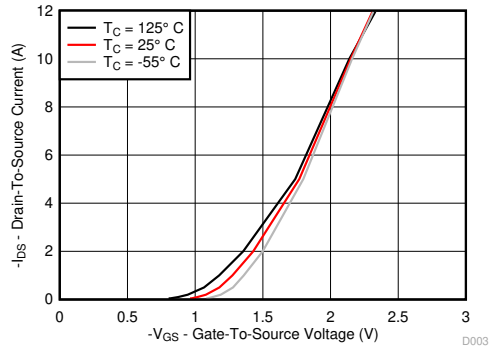
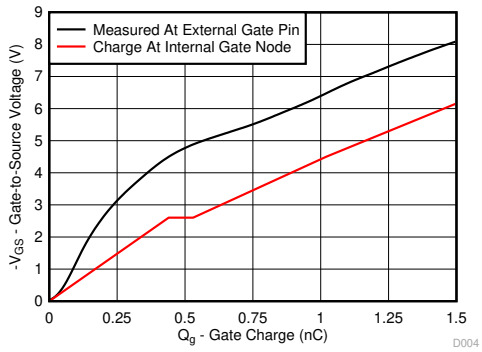


Figure 4-2. Saturation Characteristics



V_{DS} = –5V

Figure 4-3. Transfer Characteristics



I_D = –0.4A V_{DS} = –10V

Figure 4-4. Gate Charge

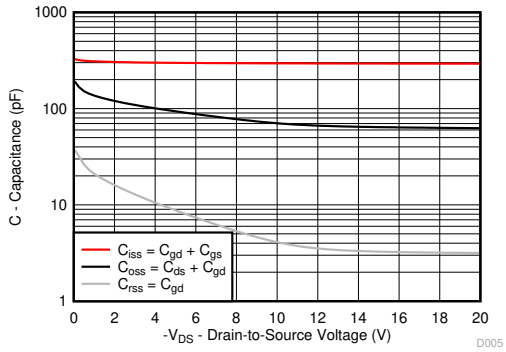
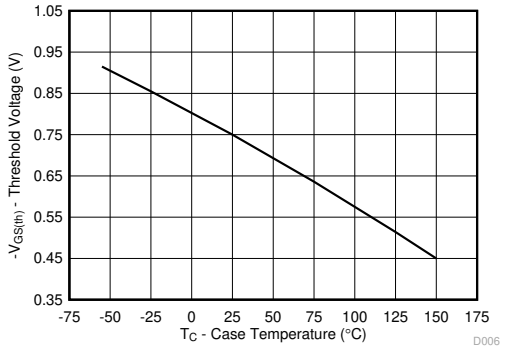


Figure 4-5. Capacitance

4.3 Typical MOSFET Characteristics (continued)

T_A = 25°C (unless otherwise stated)



I_D = –250µA

Figure 4-6. Threshold Voltage vs Temperature

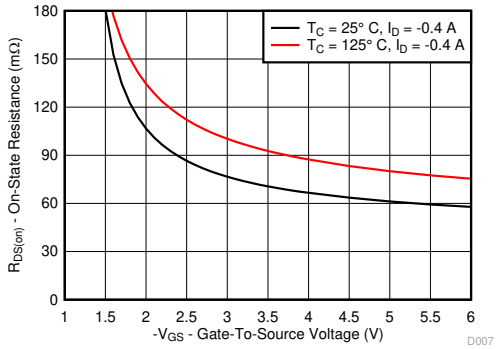
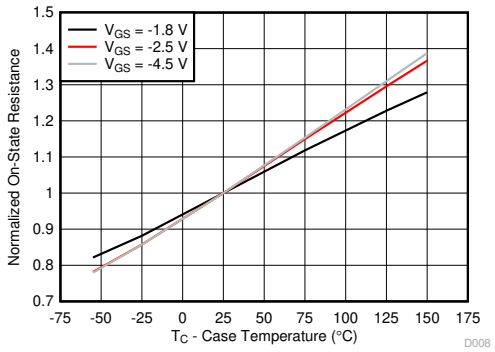


Figure 4-7. On-State Resistance vs Gate-to-Source Voltage



I_D = –0.4A

Figure 4-8. Normalized On-State Resistance vs Temperature

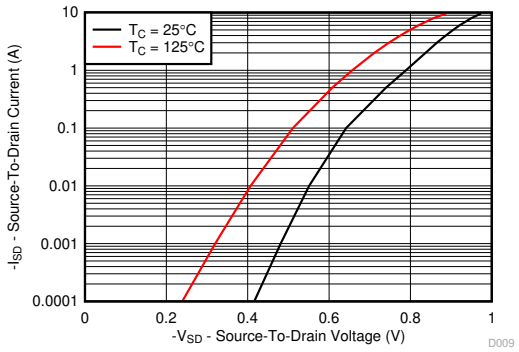
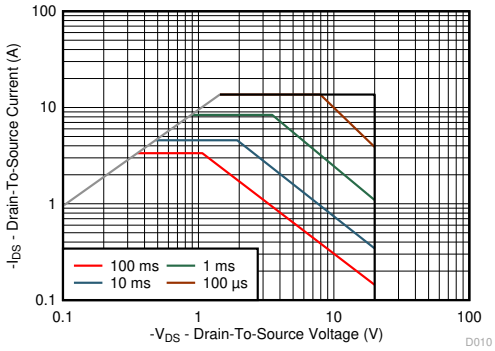
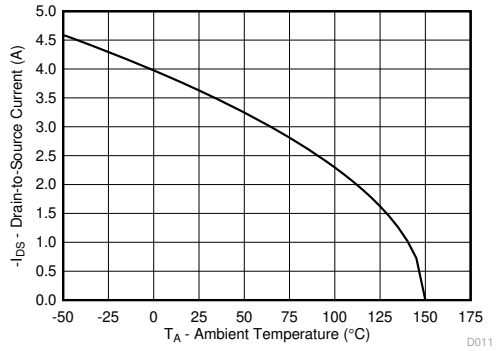


Figure 4-9. Typical Diode Forward Voltage



Single pulse, typical $R_{\theta JA}$ = 255°C/W

Figure 4-10. Maximum Safe Operating Area



Typical $R_{\theta JA}$ = 90°C/W

Figure 4-11. Maximum Drain Current vs Temperature

5 Device and Documentation Support

5.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

5.2 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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5.3 Trademarks

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5.4 Electrostatic Discharge Caution

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.

5.5 Glossary

TI Glossary	This glossary lists and explains terms, acronyms, and definitions.

6 Revision History

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

Changes from Revision B (October 2021) to Revision C (June 2024)	Page
• Updated the numbering format for tables, figures, and cross-references throughout the document	1

7 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

Table 7-1. Pin Configuration

POSITION	DESIGNATION
Pin 1	Gate
Pin 2	Source
Pin 3	Drain

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)
CSD25501F3	Active	Production	PICOSTAR (YJN) | 3	3000 | LARGE T&R	Yes	NIAU	Level-1-260C-UNLIM	-55 to 150	V
CSD25501F3.B	Active	Production	PICOSTAR (YJN) | 3	3000 | LARGE T&R	-	NIAU	Level-1-260C-UNLIM	-55 to 150	V
CSD25501F3T	Active	Production	PICOSTAR (YJN) | 3	250 | SMALL T&R	Yes	NIAU	Level-1-260C-UNLIM	-55 to 150	V
CSD25501F3T.B	Active	Production	PICOSTAR (YJN) | 3	250 | SMALL T&R	-	NIAU	Level-1-260C-UNLIM	-55 to 150	V

(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.

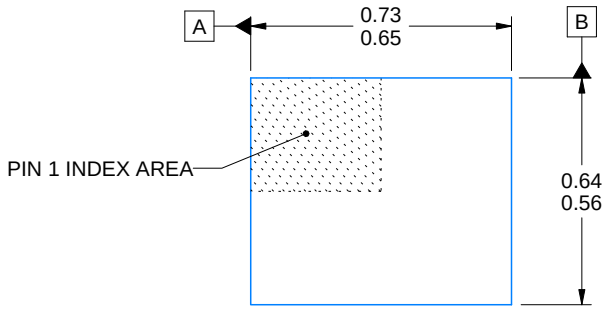
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

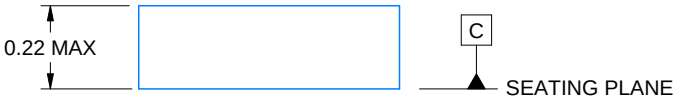
PACKAGE OUTLINE

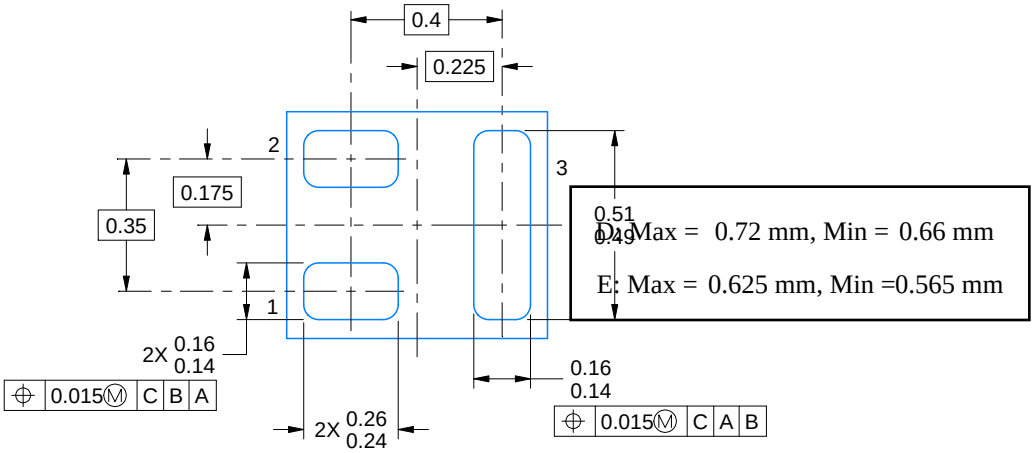
YJN0003A

PicoStar™ - 0.22 mm max height

PicoStar™





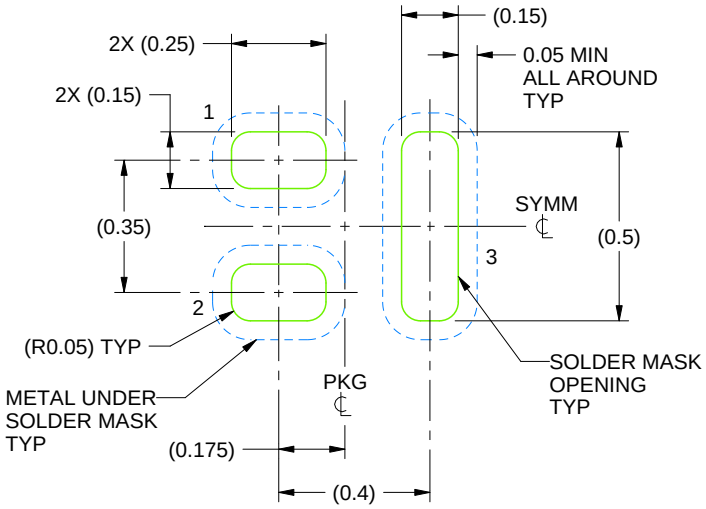


4223685/A 05/2017

NOTES:

PicoStar is a trademark of Texas Instruments.

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M
2. This drawing is subject to change without notice.
3. This package is a Pb-free bump design. Bump finish may vary. To determine the exact finish, refer to the device datasheet or contact a local TI representative.

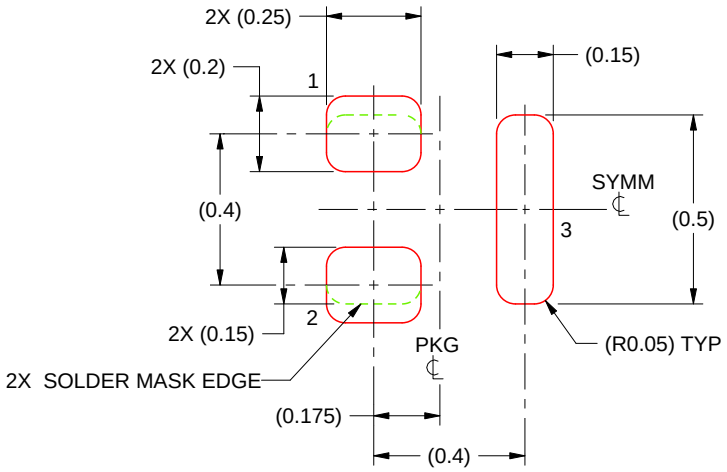


LAND PATTERN EXAMPLE
SOLDER MASK DEFINED
SCALE:50X

4223685/A 05/2017

NOTES: (continued)

4. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).



SOLDER PASTE EXAMPLE
BASED ON 0.075 - 0.1 mm THICK STENCIL
SCALE:50X

4223685/A 05/2017

NOTES: (continued)

5. 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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